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High-Tech I/M Test Procedures, Emission Standards, Quality Control Requirements, and Equipment Specifications: IM240 and Functional Evaporative System Tests

Revised

Technical Guidance

DRAFT

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Introduction

This document is the successor to the April 1994 version of "High-Tech I/M Test Procedures, Emission Standards, Quality Control Requirements, and Equipment Specifications." It incorporates changes discussed by the I/M Test Committee since April 1994 and thus includes the latest standards and procedures recommended for IM240 testing. Several major additions and changes have been made. The draft supplemental technical guidance dynamometer specifications that were issued in August of 1994 under separate cover are now incorporated, with changes discussed in Committee, into this document. This version also includes the standards for fast-passing vehicles and for heavy-duty vehicles; fast-fail references have been deleted. This version includes the evaporative system pressure tests, including the gas cap pressure test, the fuel inlet pressure test, and the canister end pressure test. Finally, this version incorporates the recommended reporting format for vehicles that fail the IM240. Many other smaller changes were made to the document as well.

§85.2205 Test Standards

(a) IM240 Emission Standards

(1) Two Ways to Pass Standards. If the corrected, composite emission rates calculated in §85.2205(b) exceed standards for any exhaust component, additional analysis of test results shall look at the second phase of the driving cycle separately. Phase 2 shall include second 94 through second 239. Second-by-second emission rates in grams, and composite emission rates in grams per mile for Phase 2 and for the entire test shall be recorded for each gas. For any given exhaust component, if the composite emission level is equal to or below the composite standard or if the Phase 2 grams per mile emission level is equal to or below the applicable Phase 2 standard, then the vehicle shall pass the test for that exhaust component.

(2) Start-up Standards. Start-up standards should be used during the first two years of program operation. Tier 1 standards are recommended for 1996 and newer vehicles and may be used for 1994 and newer vehicles certified to Tier 1 standards. The following exhaust emissions standards, in grams per mile, are recommended:

(i) Light Duty Vehicles.

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1	0.80	0.50	15.0	12.0	2.0	2.0
1991-1995	1.20	0.75	20.0	16.0	2.5	2.5
1983-1990	2.00	1.25	30.0	24.0	3.0	3.0
1981-1982	2.00	1.25	60.0	48.0	3.0	3.0
1980	2.00	1.25	60.0	48.0	6.0	6.0
1977-1979	7.50	5.00	90.0	72.0	6.0	6.0
1975-1976	7.50	5.00	90.0	72.0	9.0	9.0
1973-1974	10.0	6.00	150	120	9.0	9.0
1968-1972	10.0	6.00	150	120	10.0	10.0

(ii) High-Altitude Light Duty Vehicles.

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1983-1984	2.00	1.25	60.0	48.0	3.0	3.0
1982	2.00	1.25	75.0	60.0	3.0	3.0

(iii) Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1						
(≤3750 LVW)	0.80	0.50	15.0	12.0	2.0	2.0
(>3750 LVW)	1.00	0.63	20.0	16.0	2.5	2.5
1991-1995	2.40	1.50	60.0	48.0	3.0	3.0

1988-1990	3.20	2.00	80.0	64.0	3.5	3.5
1984-1987	3.20	2.00	80.0	64.0	7.0	7.0
1979-1983	7.50	5.00	100	80.0	7.0	7.0
1975-1978	8.00	5.00	120	96.0	9.0	9.0
1973-1974	10.0	6.00	150	120	9.0	9.0
1968-1972	10.0	6.00	150	120	10.0	10.0

(iv) High-Altitude Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1991+	3.00	2.00	70.0	56.0	3.0	3.0
1988-1990	4.00	2.50	90.0	72.0	3.5	3.5
1984-1987	4.00	2.50	90.0	72.0	7.0	7.0
1982-1983	8.00	5.00	130	104	7.0	7.0

(v) Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1						
(≤5750 LVW)	1.00	0.63	20.0	16.0	2.5	2.5
(>5750 LVW)	2.40	1.50	60.0	48.0	4.0	4.0
1991-1995	2.40	1.50	60.0	48.0	4.5	4.5
1988-1990	3.20	2.00	80.0	64.0	5.0	5.0
1984-1987	3.20	2.00	80.0	64.0	7.0	7.0
1979-1983	7.50	5.00	100	80.0	7.0	7.0
1975-1978	8.00	5.00	120	96.0	9.0	9.0
1973-1974	10.0	6.00	150	120	9.0	9.0
1968-1972	10.0	6.00	150	120	10.0	10.0

(vi) High-Altitude Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1991+	3.00	2.00	70.0	56.0	4.5	4.5
1988-1990	4.00	2.50	90.0	72.0	5.0	5.0
1984-1987	4.00	2.50	90.0	72.0	7.0	7.0
1982-1983	8.00	5.00	130	104	7.0	7.0

(vii) Heavy-Duty Trucks (greater than 8500 pounds GVWR).*

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2

* The heavy-duty truck standards provided here were calculated using new vehicle certification standards and have not be subjected to field testing. This document provides no other guidance on heavy duty truck testing. Thus, anyone interested in performing IM240 tests on heavy-duty trucks should proceed with appropriate caution.

1998+	2.00	1.30	30.0	24.0	4.0	4.0
1991-1997	3.00	1.90	60.0	48.0	6.0	6.0
1987-1990	3.00	1.90	60.0	48.0	8.0	8.0
1985-1986	5.00	3.10	75.0	60.0	8.0	8.0
1979-1984	6.00	3.80	100.0	80.0	8.0	8.0
1974-1978	10.0	6.30	150.0	120.0	10.0	10.0
1970-1973	10.0	6.30	175.0	140.0	10.0	10.0
pre-1970	20.0	12.50	200.0	160.0	15.0	15.0

(3) Final Standards. The following exhaust emissions standards, in grams per mile, are recommended for vehicles tested in the calendar years 1997 and later. Tier 1 standards are recommended for all 1996 and newer vehicles but may be used for 1984 and newer vehicles.

(i) Light Duty Vehicles.

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1	0.60	0.40	10.0	8.0	1.5	1.5
1983-1995	0.80	0.50	15.0	12.0	2.0	2.0
1981-1982	0.80	0.50	30.0	24.0	2.0	2.0
1980	0.80	0.50	30.0	24.0	4.0	4.0
1977-1979	3.00	2.00	65.0	52.0	4.0	4.0
1975-1976	3.00	2.00	65.0	52.0	6.0	6.0
1973-1974	7.00	4.50	120	96.0	6.0	6.0
1968-1972	7.00	4.50	120	96.0	7.0	7.0

(ii) High-Altitude Light Duty Vehicles.

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1983-1984	1.20	0.75	30.0	24.0	2.0	2.0
1982	1.20	0.75	45.0	36.0	2.0	2.0

(iii) Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons		Carbon Monoxide		Oxides of Nitrogen	
	Composite	Phase 2	Composite	Phase 2	Composite	Phase 2
1994+ Tier 1						
(≤3750 LVW)	0.60	0.40	10.0	8.0	1.5	1.5
(>3750 LVW)	0.80	0.50	13.0	10.0	1.8	1.8
1988-1995	1.60	1.00	40.0	32.0	2.5	2.5
1984-1987	1.60	1.00	40.0	32.0	4.5	4.5
1979-1983	3.40	2.00	70.0	56.0	4.5	4.5
1975-1978	4.00	2.50	80.0	64.0	6.0	6.0
1973-1974	7.00	4.50	120	96.0	6.0	6.0
1968-1972	7.00	4.50	120	96.0	7.0	7.0

(iv) High-Altitude Light Duty Trucks 1 (less than 6000 pounds GVWR).

Model Years	Hydrocarbons Composite	Hydrocarbons Phase 2	Carbon Monoxide Composite	Carbon Monoxide Phase 2	Oxides of Nitrogen Composite	Oxides of Nitrogen Phase 2
1988+	2.00	1.25	60.0	48.0	2.5	2.5
1984-1987	2.00	1.25	60.0	48.0	4.5	4.5
1982-1983	4.00	2.50	90.0	72.0	4.5	4.5

(v) Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons Composite	Hydrocarbons Phase 2	Carbon Monoxide Composite	Carbon Monoxide Phase 2	Oxides of Nitrogen Composite	Oxides of Nitrogen Phase 2
1994+ Tier 1						
(≤5750 LVW)	0.80	0.50	13.0	10.0	1.8	1.8
(>5750 LVW)	0.80	0.50	15.0	12.0	2.0	2.0
1988-1995	1.60	1.00	40.0	32.0	3.5	3.5
1984-1987	1.60	1.00	40.0	32.0	4.5	4.5
1979-1983	3.40	2.00	70.0	56.0	4.5	4.5
1975-1978	4.00	2.50	80.0	64.0	6.0	6.0
1973-1974	7.00	4.50	120	96.0	6.0	6.0
1968-1972	7.00	4.50	120	96.0	7.0	7.0

(vi) High-Altitude Light Duty Trucks 2 (greater than 6000 pounds GVWR).

Model Years	Hydrocarbons Composite	Hydrocarbons Phase 2	Carbon Monoxide Composite	Carbon Monoxide Phase 2	Oxides of Nitrogen Composite	Oxides of Nitrogen Phase 2
1988+	2.00	1.25	60.0	48.0	3.5	3.5
1984-1987	2.00	1.25	60.0	48.0	4.5	4.5
1982-1983	4.00	2.50	90.0	72.0	4.5	4.5

(vii) Heavy-Duty Trucks (greater than 8500 pounds GVWR).

Model Years	Hydrocarbons Composite	Hydrocarbons Phase 2	Carbon Monoxide Composite	Carbon Monoxide Phase 2	Oxides of Nitrogen Composite	Oxides of Nitrogen Phase 2
1998+	2.00	1.30	30.0	24.0	4.0	4.0
1991-1997	2.00	1.30	40.0	32.0	5.0	5.0
1987-1990	2.00	1.30	40.0	32.0	6.0	6.0
1985-1986	3.00	1.90	50.0	40.0	6.0	6.0
1979-1984	5.00	3.10	75.0	60.0	6.0	6.0
1974-1978	10.0	6.30	150.0	120.0	10.0	10.0
1970-1973	10.0	6.30	175.0	140.0	10.0	10.0
pre-1970	20.0	12.50	200.0	160.0	15.0	15.0

(4) Fast-Pass. Vehicles may be fast-passed using the following algorithm. Fast-pass shall only be used when more than one vehicle is waiting in the queue for a test.

(i) Beginning at second 30 of the driving cycle, cumulative second-by-second emission levels for each second, calculated from the start of the cycle in grams, shall be compared to the cumulative fast-pass emission standards for the second under consideration. For exhaust components subject to Phase 2 standards, cumulative second-by-second emission levels calculated from second 109 forward in grams shall be compared to cumulative second-by-second fast-pass Phase 2 emission standards for the second under consideration.

(ii) A vehicle shall pass the IM240 for a given exhaust component if either of the following conditions occur:

(A) cumulative emissions of the exhaust component for the full driving cycle are below the full cycle fast-pass standard for the second under consideration; or,

(B) at second 94 and later, if the exhaust component is subject to Phase 2 standards, cumulative Phase 2 emissions are below the Phase 2 fast-pass standards for the second under consideration;

(iii) Testing may be terminated when fast-pass criteria are met for all subject exhaust components and for purge as described in §85.2205(c)(1) or §85.2205(c)(3)(ii) in the same second.

(v) If a fast-pass determination cannot be made for all subject exhaust components and for purge before the driving cycle ends, the pass/fail determination for each component shall be based on composite or Phase 2 emissions over the full driving cycle as described in §85.2205(a)(1).

(vi) Vehicles may be fast-passed using other approaches if approved by the Administrator. States are encourage to develop and use equations to define fast-pass standards for each composite emission standard rather than using tabular standards for each second of the test. EPA-developed tabular fast-passed standards are included in Appendix A. Fast-pass standards developed by Colorado's contractor are included in Appendix B.

(b) Transient Test Score Calculations

(1) Composite Scores. The composite scores for the test shall be determined by dividing the sum of the mass of each exhaust component obtained in each second of the test by the number of miles driven in the test. The first data point is the sample taken from t=0 to t=1. The composite test value shall be calculated by the equation in (b)(1)(i):

(i) Composite gpm

$$\text{Composite gpm} = \frac{\sum_{sec=0}^{s} \text{grams of emissions}}{\sum_{sec=0}^{s} \text{miles traveled}}$$

Where: s = duration of test in seconds for fast pass
= 239 seconds for complete IM240

(2) Second-by-Second Mass Calculations. The mass of each exhaust component shall be calculated to five significant digits for each second of the test using the following equations:

(i) Hydrocarbon mass: $HC_{mass} = V_{mix} * Density_{HC} * \frac{HC_{conc}}{1000000}$

(ii) Carbon Monoxide mass: $CO_{mass} = V_{mix} * Density_{CO} * \frac{CO_{conc}}{1000000}$

(iii) Oxides of Nitrogen mass: $NO_{Xmass} = V_{mix} * Density_{NO2} * K_H * \frac{NO_{xconc}}{1000000}$

(iv) Carbon Dioxide mass: $CO_{2mass} = V_{mix} * Density_{CO2} * \frac{CO_{2conc}}{100}$

(3) Meaning of Terms.

(i) HC_{mass} = Hydrocarbon emissions in grams per second.

(ii) $Density_{HC}$ = Density of hydrocarbons is 16.33 grams per cubic foot assuming an average carbon to hydrogen ratio of 1:1.85 at 68°F and 760 mm Hg pressure.

(iii) HC_{conc} = Average hydrocarbon concentration per second of the dilute exhaust sample measured as described in §85.2226(c)(4), and corrected for background, in ppm carbon equivalent, i.e., equivalent propane * 3.

(A) $HC_{conc} = HC_e - HC_d\,(1-\frac{1}{DF})$ Where:

(B) HC_e = Hydrocarbon concentration of the dilute exhaust sample as measured in ppm carbon equivalent.

(C) HC_d = Background hydrocarbon concentration of the dilution air, sampled as described in §85.2221(b)(5), as measured in ppm carbon equivalent.

(D) DF $= \dfrac{13.4}{CO2_e + (HC_e + CO_e) * 10^{-4}}$, calculated on a second-by-second basis.

(iv) V_{mix} = The CVS flow rate in cubic feet per second corrected to standard temperature and pressure.

(v) CO_{mass} = Carbon monoxide emissions in grams per second.

(vi) $Density_{CO}$ = Density of carbon monoxide is 32.97 grams per cubic foot at 68°F and 760 mm Hg pressure.

(vii) CO_{conc} = Average carbon monoxide concentration per second of the dilute exhaust sample measured as in §85.2226(c)(4), and corrected for background, water vapor, and CO_2 extraction, in ppm.

(A) $CO_{conc} = CO_e - CO_d \, (1-\frac{1}{DF})$

(B) CO_e = Carbon monoxide concentration of the dilute exhaust in ppm.

(C) CO_d = Background carbon monoxide concentration of the dilution air, sampled as described in §85.2221(b)(5), in ppm.

(viii) NO_{xmass} = Oxides of nitrogen emissions in grams per second.

(ix) $Density_{NO2}$ = Density of oxides of nitrogen is 54.16 grams per cubic foot assuming they are in the form of nitrogen dioxide at 68°F and 760 mm Hg pressure.

(x) NO_{xconc} = Average concentration of oxides of nitrogen per second of the dilute exhaust sample measured as described in §85.2226(c)(4), and corrected for background in ppm.

(A) $NOx_{conc} = NOx_e - NOx_d \, (1-\frac{1}{DF})$

(B) NOx_e = Oxides of nitrogen concentration of the dilute exhaust sample as measure in ppm.

(C) NOx_d = Background oxides of nitrogen concentration of the dilution air, sampled as described in §85.2221(b)(5), measured in ppm.

(xi) K_H = humidity correction factor.

(A) $K_H = \frac{1}{1 - 0.0047 (H - 75)}$.

(B) H = Absolute humidity in grains of water per pound of dry air.

(C) $H = \frac{(43.478)\ R_a * P_d}{P_B - (P_d * \frac{R_a}{100})}$

(D) R_a = Relative humidity of the ambient air, percent.

(E) P_d = Saturated vapor pressure, mm Hg at the ambient dry bulb temperature. If the temperature is above 86° F, then it shall be used in lieu of the higher temperature, until EPA supplies final correction factors.

(F) P_B = Barometric pressure, mm Hg.

(xii) CO_{2mass} = Carbon dioxide emissions in grams per second.

(xiii) $Density_{CO2}$ = Density of carbon dioxide is 51.81 grams per cubic foot at 68°F and 760 mm Hg.

(xiv) CO_{2conc} = Average carbon dioxide concentration per second of the dilute exhaust sample measured as described in §85.2226(c), and corrected for background in percent.

(A) $CO_{2conc} = CO_{2e} - CO_{2d}\ (1-\frac{1}{DF})$

(B) CO_{2d} = Background carbon dioxide concentration of the dilution air, sampled as described in §85.2221(b)(5), measured in percent.

(c) Evaporative System Purge Test Standards

(1) Total Flow Method. The vehicle shall pass the purge test when the total volume of flow exceeds one standard liter. If total volume of flow is less than 1.0 standard liter at the conclusion of the transient driving cycle, the vehicle shall fail. Any measurement below the noise specification in §85.2227(b)(2)(vi) shall not be included in the total flow calculation.

(2) Total Flow Method Fast-Pass. Vehicles may be passed using the following algorithm.

(i) Beginning at second 30 of the driving cycle, cumulative second-by-second purge levels for each second, in liters, shall be compared to the cumulative fast-pass purge standards for the second under consideration.

(ii) A vehicle shall pass the purge test if cumulative purge levels are above the fast-pass standard for the second under consideration.

(iii) Testing may be terminated when a fast-pass decision has been made for purge and for all subject exhaust components as described in §85.2205(a)(4).

(v) If a fast-pass decision cannot be made for purge and for all subject exhaust components before the driving cycle ends, the pass/fail determination for purge shall be based on purge levels over the full driving cycle as described in §85.2205(c)(1).

(d) Evaporative System Pressure Test Standards

(1) Visual Check. The vehicle shall fail the evaporative system visual check if any part of the system is missing, damaged, improperly connected, or disconnected as described in §85.2222(b).

(2) Canister End Pressure Test Standards. The vehicle shall fail the pressure test if the system cannot maintain a pressure above eight inches of water for up to two minutes after being pressurized to 14±0.5 inches of water. The vehicle shall also fail if it does not posess a check valve, as identified in the Look-up Table, and if no pressure drop is detected when the gas cap is loosened as described in §85.2222(c)(4).

(3) Fuel Inlet Pressure Test.

(i) Pass/Fail Determination. Flow rate, fill pressure, and decay pressure shall be measured at 2 Hz, averaged over 1 second intervals, and curve fitted using a least squares technique. If the volume compensated pressure drop is more than the pressure loss determined from starting and ending pressures in the Pressure Decay Reference Equation in §85.2205(c)(3)(ii), the vehicle shall fail. Otherwise the vehicle shall pass. If not using volume compensation, the vehicle shall fail if the loss in pressure exceeds 6 inches of water.

(ii) Pressure Decay Reference Equation. This equation provides pressure loss values equivalent to a loss of pressure from 14 to 8 inches of water when the starting pressure is other than 14 inches of water.

$$P = 40 * (0.9967 - 2.7 * 10^{-6} * t)^{t}$$

Where:

P = Starting or ending pressure, in inches of water.

t = Time, in seconds.

(iii) Fast-Pass. Fast-pass determinations may be made anytime during the pressure decay between 20 and 120 seconds if the measured pressure exceeds the corresponding Pressure Test Reference Equation cutpoint, from §85.2205 (c)(3)(ii), by 1 inch of water pressure. The cutpoint is determined by adding 1 inch of water to the pressure value at a time t. The pressure at time t corresponds to the pressure at the equivalent "start time" plus the time in seconds between 20 and 120 when the fast pass determination is made. States may propose and the Administrator may approve other fast pass algorithms provided they minimize false results.

(iv) Pressure Drop. For vehicles without vapor control valves (burp valves), the clamp(s) shall be removed from the hose(s) and the system shall be monitored for a gradual pressure drop. If no pressure drop is detected, the vehicle shall fail the test. If the Pressure Test Look-up Table identifies the vehicle as possessing a vapor control valve, the system shall not be monitored for a loss of pressure.

(4) Gas Cap Test.

(i) Pressure Decay Method. If pressure decays by 6 inches of water or more during the 10 second period, the vehicle shall fail the fuel cap integrity test.

(ii) Flow Rate Method. The fuel cap leak rate shall be compared to an orifice with a National Institute of Standards and Technology traceable flow rate which will result in a pass/fail flow rate threshold of 60 cubic centimeters per minute of air at 30 inches of water column. If the leak rate exceeds 60 cubic centimeters per minute at a pressure of 30 inches of water column, the cap shall fail the test.

§85.2221 IM240 and Evaporative System Purge Test Procedures

(a) General Requirements

(1) Data Collection. The following information shall be determined for the vehicle being tested and used to automatically select the dynamometer inertia and power absorption settings:

(i) Vehicle type: LDGV, LDGT1, LDGT2, HDGT, and others as needed,
(ii) Chassis model year,
(iii) Make,
(iv) Model,
(v) Number of cylinders, or cubic inch displacement of the engine, and
(vi) Transmission type.

(2) Ambient Conditions. The ambient temperature, absolute humidity, and barometric pressure shall be recorded continuously during the transient or as a single set of readings up to 4 minutes before the start of the transient driving cycle.

(3) Restart. If shut off, the vehicle shall be restarted as soon as possible before the test and shall be running at least 30 seconds prior to the transient driving cycle.

(b) Pre-inspection and Preparation

(1) Accessories. All accessories (air conditioning, heat, defogger, radio, automatic traction control if switchable, etc.) shall be turned off (if necessary, by the inspector).

(2) Leaks. The vehicle shall be inspected for exhaust leaks. Audio assessment while blocking exhaust flow or gas measurement of carbon dioxide or other gases shall be acceptable. Vehicles with leaking exhaust systems shall be rejected from testing.

(3) Operating Temperature. The vehicle temperature gauge, if equipped and operating, shall be checked to assess temperature. If the temperature gauge indicates that the engine is not at normal operating temperature, the vehicle shall not be fast-failed and shall get a second-chance emission test if it fails the initial test for any criteria exhaust component. Vehicles in overheated condition shall be rejected from testing.

(4) Tire Condition. Vehicles shall be rejected from testing if the tire cords, bubbles, cuts, or other damage are visible. Vehicles shall be rejected that have space-saver spare tires on the drive axle. Vehicles may be rejected that do not have reasonably sized tires. Vehicle tires shall be visually checked for adequate pressure level. Drive wheel tires that appear low shall be inflated to approximately 30 psi, or to tire side wall pressure, or manufacturer's recommendation. Tires of vehicles being tested for the purposes of program evaluation under §51.353(c) shall have their tires inflated to tire side wall pressure.

(5) Ambient Background. Background concentrations of hydrocarbons, carbon monoxide, oxides of nitrogen, and carbon dioxide (HC, CO, NO_X, and CO_2,

respectively) shall be sampled as specified in §85.2226(b)(2)(iv) to determine background concentration of constant volume sampler dilution air. The sample shall be taken for a minimum of 15 seconds within 120 seconds of the start of the transient driving cycle, using the same analyzers used to measure tailpipe emissions except as provided in §85.2221(f)(3). Average readings over the 15 seconds for each gas shall be recorded in the test record. Testing shall be prevented until the average ambient background levels are less than 20 ppmC HC, 30 ppm CO, and 2 ppm NOx, or outside ambient air levels (not influenced by station exhaust), which ever are greater.

(6) Sample System Purge. While a lane is in operation, the CVS shall continuously purge the CVS hose between tests, and the sample system shall be continuously purged when not taking measurements.

(7) Negative Values. Negative gram per second readings shall be integrated as zero and recorded as such.

(c) Equipment Positioning and Settings

(1) Purge Equipment. If an evaporative system purge test is to be performed:

(i) The evaporative canister shall be checked unless the canister is inaccessible. A missing or obviously damaged canister shall result in failure of the visual evaporative system check.

(ii) The evaporative system shall be visually inspected for the appearance of proper hose routing and connection of hoses, unless the canister is inaccessible. If any evaporative system hose is disconnected, then the vehicle shall fail the visual evaporative system check. All hoses disconnected for the test shall be reconnected after a purge flow test is performed.

(iii) The purge flow measurement equipment shall be connected in series between the evaporative canister and the engine, preferably on the canister end of the hose. For vehicles equipped with a service port for evaporative functional testing, the measurement equipment shall be connected to the port.

(2) Roll Rotation. The vehicle shall be maneuvered onto the dynamometer with the drive wheels positioned on the dynamometer rolls. Prior to test initiation, the rolls shall be rotated until the vehicle laterally stabilizes on the dynamometer. Drive wheel tires shall be dried if necessary to prevent slippage during the initial acceleration.

(3) Cooling System. Testing shall not begin until the test-cell cooling system is positioned and activated whenever ambient temperature exceeds 72°F. The vehicle hood shall be open whenever ambient temperature exceeds 72°F. The cooling system shall be positioned to direct air to the vehicle cooling system, but shall not be directed at the catalytic converter.

(4) Vehicle Restraint. Testing shall not begin until the vehicle is restrained. Any restraint system shall meet the requirements of §85.2226(a)(5)(ii). In addition, the parking brake shall be set for front wheel drive vehicles prior to the start of the test.

(5) Dynamometer Settings. Dynamometer power absorption and inertia weight settings shall be automatically chosen from an EPA-supplied electronic look-up table which will be referenced based upon the vehicle identification information obtained in (a)(1). Vehicles not listed shall be tested using default power absorption and inertia settings as follows:

VEHICLE TYPE	NUMBER OF CYLINDERS	TRACK ROAD LOAD HORSEPOWER	TEST INERTIA WEIGHT
All	3	12.1	2000
All	4	12.8	2500
All	5	14.5	3000
All	6	14.5	3000
LDGV	8	16.2	3500
LDGT	8	17.7	4000
LDGV	10	16.2	3500
LDGT	10	19.2	4500
LDGV	12	17.7	4000
LDGT	12	20.7	5000

(6) Exhaust Collection System. The exhaust collection system shall be positioned to insure complete capture of the entire exhaust stream from the tailpipe during the transient driving cycle. The system shall meet the requirements of §85.2226(b)(2).

(d) Vehicle Conditioning

(1) Queuing Time. When the vehicle queue exceeds 20 minutes, a vehicle shall get a second-chance emission test if it fails the initial test and all criteria exhaust components are at or below 1.5 times the standard.

(2) Program Evaluation. Vehicles being tested for the purpose of program evaluation under §51.353(c) shall receive two full transient emission tests (i.e., a full 240 seconds each). Results from both tests and the test order shall be separately recorded in the test record. Emission scores and results provided to the motorist may be from either test.

(3) Discretionary Preconditioning. At the program's discretion, any vehicle may be preconditioned using any of the following methods:

(i) Non-loaded Preconditioning. Increase engine speed to approximately 2500 rpm, for up to 4 minutes, with or without a tachometer.

(ii) Loaded Preconditioning. Drive the vehicle on the dynamometer at 30 miles per hour for up to 240 seconds at road-load .

(iii) Transient Preconditioning. After maneuvering the vehicle onto the dynamometer, drive a transient cycle consisting of speed, time, acceleration, and load relationships similar to that of the transient driving cycle in §85.2221(e)(1).

(4) Second-Chance Purge Testing. Vehicles that exhibit significant purge activity during the driving cycle but do not accumulate one liter of purge shall receive a second-chance purge test. The second-chance test may be the Transient Driving Cycle or modified sequences of shorter duration designed to rapidly produce purge activity.

(e) Vehicle Emission Test Sequence

(1) Transient Driving Cycle. The vehicle shall be driven over the following cycle:

Time second	Speed mph	Time second	Speed mph	Time second	Speed mph	Time second	Speed mph	Time second	Speed mph
0	0	48	25.7	96	0	144	24.6	192	54.6
1	0	49	26.1	97	0	145	24.6	193	54.8
2	0	50	26.7	98	3.3	146	25.1	194	55.1
3	0	51	27.5	99	6.6	147	25.6	195	55.5
4	0	52	28.6	100	9.9	148	25.7	196	55.7
5	3	53	29.3	101	13.2	149	25.4	197	56.1
6	5.9	54	29.8	102	16.5	150	24.9	198	56.3
7	8.6	55	30.1	103	19.8	151	25	199	56.6
8	11.5	56	30.4	104	22.2	152	25.4	200	56.7
9	14.3	57	30.7	105	24.3	153	26	201	56.7
10	16.9	58	30.7	106	25.8	154	26	202	56.3
11	17.3	59	30.5	107	26.4	155	25.7	203	56
12	18.1	60	30.4	108	25.7	156	26.1	204	55
13	20.7	61	30.3	109	25.1	157	26.7	205	53.4
14	21.7	62	30.4	110	24.7	158	27.3	206	51.6
15	22.4	63	30.8	111	25.2	159	30.5	207	51.8
16	22.5	64	30.4	112	25.4	160	33.5	208	52.1
17	22.1	65	29.9	113	27.2	161	36.2	209	52.5
18	21.5	66	29.5	114	26.5	162	37.3	210	53
19	20.9	67	29.8	115	24	163	39.3	211	53.5
20	20.4	68	30.3	116	22.7	164	40.5	212	54
21	19.8	69	30.7	117	19.4	165	42.1	213	54.9
22	17	70	30.9	118	17.7	166	43.5	214	55.4
23	14.9	71	31	119	17.2	167	45.1	215	55.6
24	14.9	72	30.9	120	18.1	168	46	216	56
25	15.2	73	30.4	121	18.6	169	46.8	217	56
26	15.5	74	29.8	122	20	170	47.5	218	55.8
27	16	75	29.9	123	20.7	171	47.5	219	55.2
28	17.1	76	30.2	124	21.7	172	47.3	220	54.5
29	19.1	77	30.7	125	22.4	173	47.2	221	53.6
30	21.1	78	31.2	126	22.5	174	47.2	222	52.5
31	22.7	79	31.8	127	22.1	175	47.4	223	51.5
32	22.9	80	32.2	128	21.5	176	47.9	224	50.5
33	22.7	81	32.4	129	20.9	177	48.5	225	48
34	22.6	82	32.2	130	20.4	178	49.1	226	44.5
35	21.3	83	31.7	131	19.8	179	49.5	227	41
36	19	84	28.6	132	17	180	50	228	37.5
37	17.1	85	25.1	133	17.1	181	50.6	229	34
38	15.8	86	21.6	134	15.8	182	51	230	30.5
39	15.8	87	18.1	135	15.8	183	51.5	231	27
40	17.7	88	14.6	136	17.7	184	52.2	232	23.5
41	19.8	89	11.1	137	19.8	185	53.2	233	20
42	21.6	90	7.6	138	21.6	186	54.1	234	16.5
43	23.2	91	4.1	139	22.2	187	54.6	235	13
44	24.2	92	0.6	140	24.5	188	54.9	236	9.5
45	24.6	93	0	141	24.7	189	55	237	6
46	24.9	94	0	142	24.8	190	54.9	238	2.5
47	25	95	0	143	24.7	191	54.6	239	0

(2) Driving Trace. The inspector shall follow an electronic, visual depiction of the time/speed relationship of the transient driving cycle (hereinafter, the trace). The visual depiction of the trace shall be of sufficient magnification and adequate detail

to allow accurate tracking by the driver and shall permit the driver to anticipate upcoming speed changes. The trace shall also clearly indicate gear shifts as specified in §85.2221(e)(3).

(3) Shift Schedule. For vehicles with manual transmissions, inspectors shall shift gears according to the following shift schedule:

Shift Sequence *gear*	Speed *miles per hour*	Nominal Cycle Time *seconds*
1 - 2	15	9.3
2 - 3	25	47.0
De-clutch	15	87.9
1 - 2	15	101.6
2 - 3	25	105.5
3 - 2	17	119.0
2 - 3	25	145.8
3 - 4	40	163.6
4 - 5	45	167.0
5 - 6	50	180.0
De-clutch	15	234.5

Gear shifts shall occur at the points in the driving cycle where the specified speeds are obtained. For vehicles with fewer than six forward gears the same schedule shall be followed with shifts above the highest gear disregarded.

(4) Speed Excursion Limits. Speed excursion limits shall apply as follows:

(i) The upper limit is 2 mph higher than the highest point on the trace within 1 second of the given time.

(ii) The lower limit is 2 mph lower than the lowest point on the trace within 1 second of the given time.

(iii) Speed variations greater than the tolerances (such as may occur during gear changes) are acceptable provided they occur for no more than 2 seconds on any occasion.

(iv) Speeds lower than those prescribed during accelerations are acceptable provided the vehicle is operated at maximum available power during such accelerations until the vehicle speed is within the excursion limits.

(v) Exceedances of the limits in §85.2221(i) through §85.2221(iii) shall automatically result in a void test. The station manager can override the automatic void of a test if the manager determines that the conditions specified in §85.2221(e)(4)(iv) occurred. Tests shall be aborted if the upper excursion limits are exceeded. Tests may be aborted if the lower limits are exceeded.

(5) Speed Variation Limits.

(i) A linear regression of feedback value on reference value shall be performed on each transient driving cycle for each speed using the method of least squares, with the best fit equation having the form: $y = mx + b$, where:

(A) y = The feedback (actual) value of speed;

(B) m = The slope of the regression line;

(C) x = The reference value; and

(D) b = The y-intercept of the regression line.

(ii) The standard error of estimate (SE) of y on x shall be calculated for each regression line. A transient driving cycle lasting the full 240 seconds that exceeds the following criteria shall be void and the test shall be repeated:

(A) SE = 2.0 mph maximum.

(B) m = 0.96 - 1.01.

(C) r^2 = 0.97 minimum.

(D) b = ±2.0 mph.

(iii) A transient driving cycle that ends before the full 240 seconds that exceeds the following criteria shall be void and the test shall be repeated:

(A) SE = *(Reserved)*

(B) m = *(Reserved)*

(C) r^2 = *(Reserved)*

(D) b = *(Reserved)*

(6) Distance Criteria. The actual distance traveled for the transient driving cycle and the equivalent vehicle speed (i.e., roll speed) shall be measured. If the absolute difference between the measured distance and the theoretical distance for the actual test exceeds 0.05 miles, the test shall be void.

(7) Vehicle Stalls. Vehicle stalls during the test shall result in a void and a new test. More than 3 stalls shall result in test failure.

(8) Dynamometer Controller Check. For each test, the measured horsepower, and inertia if electric simulation is used, shall be integrated from 55 seconds to 81 seconds (divided by 26 seconds), and compared with the theoretical road-load horsepower (for the vehicle selected) integrated over the same portion of the cycle. The same procedure shall be used to integrate the horsepower between 189 seconds to 201 seconds (divided by 12 seconds). The theoretical horsepower shall be calculated based on the observed speed during the integration interval. If the absolute difference between the theoretical horsepower and the measured horsepower exceeds 0.5 hp, the test shall be void. For vehicles over 8500 pounds GVWR, if the absolute difference between the theoretical horsepower and the

measured horsepower exceeds 2 hp, the test shall be void. Alternate error checking methods may be used if shown to be equivalent.

(9) Inertia Weight Selection. Operation of the inertia weight selected for the vehicle shall be verified as specified in §85.2226(a)(4)(iii). For systems employing electrical inertia simulation, an algorithm identifying the actual inertia force applied during the transient driving cycle shall be used to determine proper inertia simulation. For all dynamometers, if the observed inertia is more than 1% different from the required inertia, the test shall be void.

(10) CVS Operation. The CVS operation shall be verified for each test for a CFV-type CVS by measuring either the absolute pressure difference across the venturi or measuring the blower vacuum behind the venturi for minimum levels needed to maintain choke flow for the venturi design. The operation of an SSV-type CVS shall be verified throughout the test by monitoring the difference in pressure between upstream and throat pressure. The minimum values shall be determined from system calibrations. Monitored pressure differences below the minimum values shall void the test.

(11) Fuel Economy. For each test, the health of the overall analysis system shall be evaluated by checking a test vehicle's fuel economy for reasonableness, relative to upper and lower limits, representing the range of fuel economy values normally encountered for the test inertia and horsepower selected. For each inertia selection, the upper fuel economy limit shall be determined using the lowest horsepower setting typically selected for the inertia weight, along with statistical data, test experience, and engineering judgment. A similar process for the lower fuel economy limit shall be used with the highest horsepower setting typically selected for the inertia weight. For test inertia selections where the range of horsepower settings is greater than 5 horsepower, at least two sets of upper and lower fuel economy limits shall be determined and appropriately used for the selected test inertia. Tests with fuel economy results in excess of 1.5 times the upper limit shall result in a void test.

(f) Emission Measurements

(1) Exhaust Measurement. The emission analysis system shall sample and record dilute exhaust HC, CO, CO_2, and NO_X during the transient driving cycle as described in §85.2226(c).

(2) Purge Measurement. The analysis system shall sample and record the purge flow in standard liters per second and total volume of flow in standard liters over the course of the actual driving cycle as described in §85.2227(b).

(3) Integrity Measurement. The analysis system shall measure and record the integrity of the evaporative system and the gas cap as described in §85.2227(c).

§85.2222 Evaporative System Pressure Test Procedures

(a) General Requirements

(1) The on-vehicle pressure tests described in §85.2222(c) and (d) shall be performed after any tailpipe emission test to be performed on a vehicle. Gas cap tests described in §85.2222(e) and (f) may be performed before or after the tailpipe emission test.

(2) The pressure test shall be conducted in a manner that minimizes changes in temperature, since pressure measurements are affected by changes in the vapor space temperature.

(3) The Look-up Table identifies which on-vehicle pressure test to perform on a given vehicle. Vehicles receiving the canister end pressure test specified in §85.2222(c) do not need to receive any other pressure tests. Vehicles receiving the fuel inlet pressure test specified in §85.2222(d) should also be given one of the gas cap pressure tests specified in §§85.2222(e) and (f).

(4) Alternative procedures may be used if they are shown to be equivalent or better to the satisfaction of the Administrator. Except in the case of government-run test facilities claiming sovereign immunity, any damage done to the evaporative emission control system during this test shall be repaired at the expense of the inspection facility.

(b) Pre-inspection and Preparation

(1) The evaporative canister(s) shall be visually checked to the degree practical. A missing or obviously damaged canister(s) shall fail the visual evaporative system check.

(2) The evaporative system hoses shall be visually inspected for the appearance of proper routing, connection, and condition, to the degree practical. If any evaporative system hose is misrouted, disconnected, or damaged, the vehicle shall fail the visual evaporative system check.

(3) If the gas cap is missing, obviously defective or the wrong style cap for the vehicle, the vehicle shall fail the visual evaporative system check.

(c) Canister-End Pressure Test

(1) Equipment Set-up. Test equipment shall be connected to the fuel tank canister hose at the canister end. The gas cap shall be checked to ensure that it is properly, but not excessively tightened, and shall be tightened if necessary.

(2) Pressure Value. The system shall be pressurized to 14 ±0.5 inches of water without exceeding 26 inches of water system pressure.

(3) Stability. Close off the pressure source, seal the evaporative system and monitor pressure decay for up to two minutes.

(4) Depressurization. Loosen the gas cap after a maximum of two minutes and monitor for a sudden pressure drop, indicating that the fuel tank was pressurized.

(5) Reconnection. The inspector shall carefully ensure that all items disconnected or lossened in the course of the test are properly reconnected at the conclusion of the test.

(d) Fuel Inlet Pressure Test

(1) Equipment Set-up. The vapor vent line(s) from the gas tank to the canister(s) shall be clamped off as close to the canister(s) as practical without damaging evaporative system hardware. If the line(s) can not be clamped (for example a rigid line), they shall be removed at the canister(s) and capped or plugged. Dual fuel tanks shall be checked individually if the complete vapor control system can not be accessed by pressurizing from the fill pipe interface of only one fuel tank. A fuel inlet adapter, as specified in §85.2227(c), appropriate to the style of fuel inlet on the vehicle (not the gas cap on the vehicle) shall be selected based on a software prompt and shall be installed on the vehicle's fuel inlet.

(2) Pressure Value. The gas tank shall be pressurized to a value at or slightly above the minimum test pressure specified in the Look-up Table.

(3) Stability. Pressure stability shall be maintained for a period of 10 seconds prior to the start of the pressure decay measurement. Pressure shall not increase by more than 0.5 inches of water during the first 20 seconds of the decay measurement. Alternate definitions of stability may be proposed by the state and approved by the Administrator provided they minimize the risk of false results.

(4) Volume Compensation. (Optional) Pressure decay measurements are affected by the vapor volume (fuel tank level) in the fuel tank. Volume-compensated pressure decay measurements will increase test repeatability, and are therefore recommended. Measure the volume-compensated pressure decay for up to 120 seconds after stability is achieved, using the equation in §85.2222(d)(5). This equation is based on normalizing the pressure decay measurements to a vapor volume of 50 liters. States may propose and the Administrator may approve other methods of compensation for differences in fuel tank vapor volume.

(5) $$P = P_0 * k^{\left(t * \frac{V}{V_s}\right)}$$

Where:

P = Pressure, in inches of water at time t, compensated for differences in fuel tank vapor space volume.

P_0 = The stabilized pressure at the start of the decay portion of the pressure test, in inches of water.

k = A constant derived from curve fitting the pressure/time data from the decay portion of the pressure test, using the equation:

$$P = P_0 * k^t$$

t = Time measured from the start of the decay portion of the pressure test, in seconds.

V_s = Reference volume of the fuel vapor space, 50 liters.

V = Volume of the fuel vapor space, in liters, calculated using the following equation:

$$V = \left(P_b * 13.6 + \frac{\text{Æ}P}{2}\right) * \frac{\text{Æ}V}{(\text{Æ}P + \text{Æ}P_L)}$$

Where:

P_b = Barometric pressure, in inches of Hg.

ÆP = Pressure increase during the fill period, in inches of water.

ÆV = The flow meter measured volume of gas which pressurizes the vapor space, in liters at 20 C and 1 atmosphere.

$\text{Æ}P_L$ = The loss in pressure due to the presence of a leak during the fill process, in inches of water.

$$\text{Æ}P_L = {}_{t=0}^{\;t}\, P_0 * k^{\left(\frac{\mathit{ln}\, P_t - \mathit{ln}\, P_0}{\mathit{ln}\, k} - 1\right)} - P_0 * k^{\left(\frac{\mathit{ln}\, P_t - \mathit{ln}\, P_0}{\mathit{ln}\, k}\right)}$$

Where:

_ = Summation of the second-by-second pressure loss during the fill period.

P_0 = The stabilized pressure at the start of the decay portion of the pressure test, in inches of water.

k = A constant derived from curve fitting the pressure/time data from the <u>decay</u> portion of the pressure test, using the equation:

$$P = P_0 * k^t$$

P_t = Pressure values reported in one second intervals during the <u>fill</u> period, in inches of water.

(e) Gas <u>Cap Leak Test - Pressure</u> Decay <u>Method</u>

(1) The fuel cap shall be removed from the fuel inlet and installed on a test rig with a nominal 1 liter head space and be pressurized to 28±1.0 inch of water.

(2) The pressure decay shall be monitored for 10 seconds after stability is achieved for 10 seconds.

(3) The fuel cap shall be replaced on the fuel inlet and tightened appropriately.

(f) Gas Cap Leak Test - Flow Rate Method

(1) The fuel cap shall be removed from the fuel inlet and installed on the flow test device using the adapter appropriate for the fuel cap, as specified in §85.2227(c).

(2) The fuel cap shall be pressurized to approximately 30 inches of water until flow rate measurements meeting the requirements of §85.2205(d)(4)(ii) are met.

(3) The fuel cap shall be replaced on the fuel inlet and tightened appropriately.

§85.2226 IM240 Equipment Specifications

(a) Dynamometer Specifications

(1) General Requirements.

(i) The dynamometer structure (e.g., bearings, rollers, pit plates, etc.) shall accommodate all light-duty vehicles and light-duty trucks up to 8500 pounds GVWR.

(ii) Road load horsepower and inertia simulation shall be automatically selected based on the vehicle parameters in the test record.

(iii) Alternative dynamometer specifications or designs may be proposed by a state and approved based upon a determination by the Administrator that, for the purpose of properly conducting an approved short test, the evidence supporting such deviations will not cause improper vehicle loading .

(2) Power Absorption.

(i) Coefficients. The coefficients A_V, B_V, and C_V, from vehicle track coast down testing, and referenced in the equations in this section are those specified during new car certification, or as specified by a vehicle class designator determined by the Administrator. Coefficients shall be calculated to a minimum of five (5) significant digits by the equations specified in §85.2226(a)(2)(i)(A) through §85.2226(a)(2)(i)(C). Power fractions determined from track coast-down data shall be calculated to a minimum of two (2) significant digits as specified in §85.2226(a)(2)(i). In the absence of new car certification coefficients information or a vehicle class designator identifying a power fraction, the default power fractions in §85.2226(a)(2)(i)(J) shall be used.

(A) $$A_V = \frac{A_V PF}{50} * (TRLHP_{@\ 50\ mph}) \quad \text{hp/mph}$$

(B) $$B_V = \frac{B_V PF}{2500} * (TRLHP_{@\ 50\ mph}) \quad \text{hp/mph}^2$$

(C) $$C_V = \frac{C_V PF}{125000} * (TRLHP_{@\ 50\ mph}) \quad \text{hp/mph}^3$$

(D) Where $A_V PF$, $B_V PF$, and $C_V PF$ are power fractions (PF), and indicate the fraction of the total power reflected by each coefficient A_V, B_V, and C_V.

(E) $A_V PF + B_V PF + C_V PF = 1$

(F) Derivation of $A_V PF$, $B_V PF$, and $C_V PF$ from known track coast-down curves shall be computed as follows:

(1) $$A_V PF = \frac{A_V\,(50)}{\{A_V\,(50) + B_V\,(2500) + C_V\,(125{,}000)\}}$$

(2) $$B_V PF = \frac{B_V\,(2500)}{\{A_V\,(50) + B_V\,(2500) + C_V\,(125{,}000)\}}$$

(3) $$C_V PF = \frac{C_V\,(125{,}000)}{\{A_V\,(50) + B_V\,(2500) + C_V\,(125{,}000)\}}$$

(4) Default values:

$A_V PF = 0.35$

$B_V PF = 0.10$

$C_V PF = 0.55$

(ii) Vehicle Loading. The true vehicle loading used during the transient driving cycle shall follow the equation in §85.2226(a)(2)(iii) between 10 and 60 mph. The dynamometer controls shall set the dynamometer loading to achieve the coast-down target time (±1 second) with the vehicle on the dynamometer using the vehicle-specific inertia test weights. A conversion equation or table of target time versus horsepower for the dynamometer design shall be used. Target time shall be converted to horsepower by the equation §85.2226(a)(2)(iv) or pre-defined horsepower values may be used.

(iii) $$TRLHP_{@\ Obmph} = \{A_V * Obmph\} + \{B_V * Obmph^2\} + \{C_V * Obmph^3\}$$

Av, Bv, Cv = Coefficients specified in §85.2226(a)(2)(i) for vehicle track coast down curves.

Obmph = Observed mph

TRLHP = Track Road Load Horsepower, which includes loading contributions from the power absorber, parasitic losses, and tire/roll interface losses.

(iv) $$\text{Track Road-Load Horsepower} = \frac{\left(\frac{0.5 * ETW}{32.2}\right) * (V_1^{\,2} - V_2^{\,2})}{(550 * ET)}$$

ET = Elapsed time for the vehicle on the road to coast down from 55 to 45 mph, and from 22 to 18 mph

ETW = Inertia weight in pounds

V_1 = Initial velocity in feet/second (i.e., velocity at either 55 or 22 mph)

V_2 = Final velocity in feet/second (i.e., velocity at either 45 or 18 mph)

(v) In practice, the true vehicle loading is derived from equations of "force" (i.e., F=MA). In determining vehicle load on a dynamometer, applied loads in units of force tangential to the roll surface are not dependent on the roll diameter used, whereas applied loads in units of torque of horsepower are dependent on the roll diameter. The equation in §85.2226(a)(2)(vi) may be used to convert track road-load horsepower values in §85.2226(a)(2)(iii) to units of force.

(vi) $TRLF_{@\ Obmph} = \{A_f\} + \{B_f * Obmph\} + \{C_f * Obmph^2\}$

TRLF = Track Road-Load Force (in units of pounds)

A_f = $375 * A_v$ (A_v in HP/mph units)

B_f = $375 * B_v$ (B_v in HP/mph^2 units)

C_f = $375 * C_v$ (C_v in HP/mph^3 units)

A_f, B_f, C_f = Equivalent force coefficients to the coefficients specified in §85.2226(a)(2)(i) for vehicle track coast down curves.

(vii) Range and Curve of Power Absorber. The range of power absorber at 50 mph shall be sufficient to cover track road-load horsepower (TRLHP) values between 4 and 35 horsepower. The absorption shall be adjustable across the required horsepower range at 50 mph in 0.1 horsepower increments. The accuracy of the power absorber shall be ±0.25 horsepower or ±2% of point whichever is greater.

(viii) Parasitic Losses (General Requirements). The parasitic losses in each dynamometer system (such as windage, bearing friction, and system drive friction) shall be characterized between 10 and 60 mph upon initial acceptance. There shall be no sudden discontinuities in parasitic losses below 10 mph. Further, when added to the lowest possible loading of the power absorber (dynamometer motoring is considered a negative load), the parasitic losses must be sufficiently small such that proper loading will occur between 10 and 60 mph for a vehicle with a 50 mph track road-load horsepower value of 4 horsepower. The parasitic horsepower losses shall be characterized either digitally in five mph increments and linearly interpolated in-between, or the data at 10 mph increments shall fit the equation in §85.2226(a)(2)(ix) to within 2 percent of point.

(ix) $PLHP = \{A_p * (Obmph)\} + \{(B_p) * (Obmph)^2\} + \{(C_p) * (Obmph)^3\}$

PLHP= Dynamometer parasitic losses.

A_p, B_p, and C_p are curve coefficients necessary to properly characterize the dynamometer parasitic losses for the inertia weight(s) used.

(x) Parasitic Losses (Low Speed Requirements). The coast down time of the dynamometer between 8 and 12 mph shall be greater than or equal to the value calculated by the equation in §85.2226(a)(2)(xi) when the dynamometer is set for a 2000 pound vehicle with a track road-load horsepower of 4 horsepower at 50 mph.

(xi) Low Speed Loading. The following procedure is used to determine if a dynamometer system is correctly loading a vehicle with an ETW of 2000 pounds and a TRLHP of 6.0 horsepower at low speeds. Use "default" coefficients from §85.2226(a)(2)(i)(F)(4). Dynamometer must be warmed up prior to this procedure.

(A) Select vehicle with a driven axle weight between 1200 and 1300 pounds (sandbags or other ballast may be used to achieve this weight). Record vehicles driven axle weight to the nearest pound.

(B) Calculate the actual tire/roll interface losses (ATRL) using the following sub procedure.

(1) Determine PLHP for dynamometer system being tested.

(2) Calculate GTRL using equations from §§85.2226(a)(2)(xiii) and (xv) or (xvi).

(3) Calculate IHP using the following formula:

IHP = TRLHP-PLHP-GTRL

(4) Set dynamometer based on IHP calculated is step C above.

(5) Perform dynamometer coast down with vehicle selected in step 1 correctly positioned on rolls. Record coast down time from 12 mph to 8 mph.

(6) Calculate new TRLHP based on 12 mph to 8 mph coast

(7) Calculate actual tire/roll interface losses (ATRL) using the following equation.

ATRL= TRLHP-PLHP-IHP

(C) Using calculated ATRL determine new IHP using the following formula:

IHP = TRLHP-PLHP-ATRL

(D) Set dynamometer based on IHP calculated is step 3 above.

(E) Perform dynamometer coast down with vehicle selected in step 1 correctly positioned on rolls. Record coast down time from 12 mph to 8 mph.

(F) The maximum, average, and minimum time limits for the on-dynamometer coast-down window at 10 mph ($DT_{Max\ @\ 10\ mph}$, $DT_{Ave\ @\ 10\ mph}$, and $DT_{Min\ @\ 10\ mph}$) shall be calculated by the following equations.

$$DT_{Max\ @\ 10\ mph} = \frac{\left(\frac{0.5 * ETW}{32.17405}\right) * (V_{12}^2 - V_8^2)}{550 * (TRLHP_{@\ 10\ mph} - 0.088\ HP)}$$

$$DT_{Ave\ @\ 10\ mph} = \frac{\left(\frac{0.5 * ETW}{32.17405}\right) * (V_{12}^2 - V_8^2)}{550 * (TRLHP_{@\ 10\ mph})}$$

$$DT_{Min\ @\ 10\ mph} = \frac{\left(\frac{0.5 * ETW}{32.17405}\right) * (V_{12}^2 - V_8^2)}{550 * (TRLHP_{@\ 10\ mph} + 0.088\ HP)}$$

(xii) Tire/Roll Interface Losses. Generic tire/roll interface losses shall be determined for each dynamometer design used, and applied to obtain proper vehicle loading. A means to select or determine the appropriate generic tire/roll interface loss for each test vehicle shall be employed. Dynamometer design parameters include roll diameter, roll spacing, and roll surface finish. Generic tire/roll interface losses may be determined by the acceptance procedures in §85.2234(b)(4). Alternatively, generic values determined by the Administrator, or by a procedure accepted by the Administrator, may be used. The equation in §85.2226(a)(2)(xiii) may be used to quantify tire/roll interface losses. Coefficients for equation in §85.2226(a)(2)(xiii) shall be calculated to a minimum of five (5) significant digits by the equations specified in §85.2226(a)(2)(xiii)(A) through §85.2226(a)(2)(xiii)(I). Tire loss power fractions determined from track coast-down data shall be calculated to a minimum of two (2) significant digits as specified in §85.2226(a)(2)(xiii)(J). In the absence of new car certification information or a vehicle class designator identifying a tire loss power fraction, the default tire loss power fractions indicated equations §85.2226(a)(2)(xiii)(E) through §85.2226(a)(2)(xiii)(I) shall be used as specified in §85.2226(a)(2)(xiii)(J).

(xiii) $GTRL_{@\ Obmph} = \{A_t * (Obmph)\} + \{B_t * (Obmph)^2\} + \{C_t * (Obmph)^3\}$

$GTRL_{@\ Obmph}$ = Generic Tire/Roll Interface losses at the observed mph

Where: A_t, B_t, and C_t are curve coefficients necessary to properly characterize the tire/roll interface losses.

(A)	A_t	=	$(A_tPF / 50)$	*	(GTRL@ 50 mph)	hp/mph
(B)	B_t	=	$(B_tPF / 2500)$	*	(GTRL@ 50 mph)	hp/mph2
(C)	C_t	=	$(C_tPF / 125{,}000)$	*	(GTRL@ 50 mph)	hp/mph^3
(D)	A_{t8}	=	(0.76/ 50)	*	(GTRL@ 50 mph)	hp/mph
(E)	B_{t8}	=	(0.33 / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(F)	C_{t8}	=	(-0.09 / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3
(G)	A_{t20}	=	(0.65 / 50)	*	(GTRL@ 50 mph)	hp/mph
(H)	B_{t20}	=	(0.48 / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(I)	C_{t20}	=	(-0.13 / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3

(J) Where:

(1) A_t, B_t, and C_t are curve coefficients necessary to properly characterize the tire/roll interface losses.

(2) A_{t8}, B_{t8}, and C_{t8} are curve coefficients when using twin 8.625 inch diameter rolls.

(3) A_{t20}, B_{t20}, and C_{t20} are curve coefficients when using twin 20.0 inch diameter rolls.

(4) A_tPF, B_tPF, and C_tPF indicate the fraction of the total tire loss power fraction reflected by each coefficient A_t, B_t, and C_t.

(5) $A_tPF + B_tPF + C_tPF = 1$

(6) Derivation of A_tPF, B_tPF, and C_tPF from known track or dynamometer data shall be computed as follows:

$$A_tPF = \frac{A_t\ (50)}{\{A_t\ (50) + B_t\ (2500) + C_t\ (125{,}000)\}}$$

$$B_tPF = \frac{B_t\ (2500)}{\{A_t\ (50) + B_t\ (2500) + C_t\ (125{,}000)\}}$$

$$C_tPF = \frac{C_t\ (125{,}000)}{\{A_t\ (50) + B_t\ (2500) + C_t\ (125{,}000)\}}$$

(xiv) In the absence of new car certification GTRL@ 50 mph or a vehicle class designator, the GTRL@ 50 mph shall be calculated

(A) by the equation in §85.2226(a)(2)(xv) when using twin 8.625 inch diameter rolls

(B) by the equation in §85.2226(a)(2)(xvi) when using twin 20.0 inch diameter rolls

(xv) For 8.625" dynamometers:

GTRL@ 50 mph = (-0.378193) + {(0.0033207) * (DAXWT)}

Where: DAXWT = Axle weight on the drive tires
GTRL@ 50 mph = Losses for 8.625 inch diameter roll

(xvi) For 20" dynamometers:

GTRL@ 50 mph = (reserved) + {(reserved) * (DAXWT)}

Where: DAXWT = Axle weight on the drive tires
GTRL@ 50 mph = Losses for 20.0 inch diameter roll

(xvii) Indicated Horsepower. The power absorption for each test shall be selected at 50 mph. The indicated power absorption (IHP) at 50 mph after accounting for parasitic and generic tire losses shall be determined by the equation in §85.2226(a)(2)(xv).

(xviii) $IHP_{@\ 50\ mph} = TRLHP_{@\ 50\ mph} - PLHP_{@\ 50\ mph} - GTRL_{@\ 50\ mph}$

(xix) In systems where the power absorption is actively controlled, the indicated horsepower at each speed between 0 and 60 mph shall conform to the equation in §85.2226(a)(2)(xvii). Approximations for a smooth curve with no discontinuities may be used between 0 and 10 mph.

(xx) $IHP_{@\ Obmph} = TRLHP_{@\ Obmph} - PLHP_{@\ Obmph} - GTRL_{@\ Obmph}$

(3) Rolls.

(i) Size and Type. The dynamometer shall be equipped with twin rolls. The rolls shall be coupled side to side. In addition, the front and rear rolls shall be coupled. The dynamometer roll diameter shall be between 8.5 and 21.0 inches. The spacing between the roll centers shall comply with the equation in §85.2226(a)(3)(ii) to within +0.5 inches and -0.25 inches. The parasitic and generic tire/roll interface losses for the specific roll diameter, spacing, and surface finish used shall be determined as indicated in §85.2226(a)(2)(viii), (a)(2)(ix), and §85.2226(a)(2)(xii) as necessary to properly load vehicles as defined in §85.2226(a)(2)(ii) and §85.2226(a)(2)(iii). The dynamometer rolls shall accommodate an inside track width of 30 inches and an outside track width of at least 100 inches.

(ii) Roll Spacing = (24.375 + D) * SIN 31.5153_

D = dynamometer roll diameter.

Roll spacing and dynamometer roll diameter are expressed in inches.

(iii) Design. The roll size, surface finish, and hardness shall be such that tire slippage on the first acceleration of the transient driving cycle is minimized under all weather conditions; that the specified accuracy of the distance measurement is maintained; and that tire wear and noise are minimized.

(4) Inertia.

(i) Mechanical Inertia Simulation. The dynamometer shall be equipped with mechanical flywheels providing test inertia weights between at least 2000 to 5500 pounds, in increments of no greater than 500 pounds. The tolerance on the base inertia weight and the flywheels shall be within 1% of the specified test weights. The proper inertia weight for any test vehicle shall be selectable.

(ii) Electric Inertia Simulation. Electric inertia simulation, or a combination of electric and mechanical simulation may be used in lieu of mechanical flywheels, provided that the performance of the electrically simulated inertia complies with the following specifications. Exceptions to these specifications may be allowed upon a determination by the Administrator that such exceptions would not significantly increase vehicle loading or emissions for the purpose of properly conducting an approved short test.

(A) System Response. The torque response to a step change shall be at least 90% of the requested change within 100 milliseconds after a step change is commanded by the dynamometer control system, and shall be within 2 percent of the commanded torque by 300 milliseconds after the command is issued. Any overshoot of the commanded torque value shall not exceed 25 percent of the torque value.

(B) Simulation Error. An inertia simulation error (ISE) shall be continuously calculated any time the actual dynamometer speed is above 10 MPH and below 60 MPH. The ISE shall be calculated by the equation in §85.2226(a)(4)(ii)(C), and shall not exceed 1 percent of the inertia weight selected (IW_s) for the vehicle under test.

(C) $ISE = (IW_s - I_t) / (IW_s) * 100$

(D) $I_t = I_m + \left(\frac{1}{V}\right) \int_0^t (F_m - F_{rl})\, DT$

Where:

I_t = Total inertia being simulated by the dynamometer (kg)

I_t (lb force) = It (kg) * 2.2046

I_m = Base (mechanical inertia of the dynamometer (kg)

V = Measured roll speed (m/s)

F_m = Force measured by the load cell (translated to the roll surface) (N)

F_{rl} = Road load force (N) required by IHP at the measured roll speed (V)

t = Time (sec)

(iii) Inertia Weight Selection. For dynamometer systems employing mechanical inertia flywheels, the test system shall be equipped with a method, independent from the flywheel selection system, that identifies which inertia weight flywheels are actually rotating during the transient driving cycle.

(5) Other Requirements.

(i) Test Distance and Vehicle Speed. The total number of dynamometer roll revolutions shall be used to calculate the distance traveled. Pulse counters may be used to calculate the distance directly if there are at least 16 pulses per revolution. The measurement of the actual roll distance for the composite and each phase of the transient driving cycle shall be accurate to within ±0.01 mile. The measurement of the roll speed shall be accurate to within ±0.1 mph. Roll speed measurement systems shall be capable of accurately measuring a 3.3 mph per second acceleration rate over a one second period with a starting speed of 10 mph.

(ii) Vehicle Restraint. The vehicle shall be restrained during the transient driving cycle. The restraint system shall be designed to minimize vertical and horizontal force on the drive wheels such that emission levels are not significantly affected. The restraint system shall allow unobstructed vehicle ingress and egress and shall be capable of safely restraining the vehicle under all reasonable operating conditions.

(iii) Vehicle Cooling. The test system shall provide for a method to prevent overheating of the vehicle. The cooling method shall direct air to the cooling system of the test vehicle. The cooling system capacity shall be 5400 ±300 SCFM within 12 inches (30.5 cm) of the intake to the vehicle's cooling system. The cooling system design shall avoid improper cooling of the catalytic convertor.

(iv) Four-Wheel Drive. If used, four-wheel drive dynamometers shall insure the application of correct vehicle loading as defined in §85.2226(a)(2) and shall not damage the four wheel drive system of the vehicle. Front and rear wheel rolls shall maintain speed synchronization within 0.2 mph.

(v) Augmented Braking. Fully automatic augmented braking shall be used from seconds 85 through 95 and after second 223 of the driving cycle. Fully automatic augmented braking may be used in other deceleration periods of the driving cycle with the approval of the Administrator. During the periods of augmented braking the operator shall be made aware that augmented braking is occurring and shall be trained not to use the vehicle accelerator during these periods. It shall be automatically interlocked such that it can be actuated only while the vehicle brakes are applied. Simultaneous engine acceleration is systematically prevented through periodic quality assurance.

(b) Constant Volume Sampler

(1) General Design Requirements.

(i) Venturi Type. A constant volume sampling (CVS) system of the critical flow venturi (CFV) or the sub-sonic venturi (SSV) type shall be used to collect vehicle exhaust samples. The CVS system and components shall generally conform to the specifications in §86.109-90.

(ii) CVS Flow Size. The CVS system shall be sized in a manner that prevents condensation in the dilute sample over the range of ambient conditions to be encountered during testing. A 700 SCFM system is assumed to satisfy this requirement. The range of ambient conditions may require the use of heated sample lines. A 350 SCFM CVS system and heated lines may be used to eliminate condensation and to increase measured concentrations for better resolution. Should the heated sample lines be used, the sample line and components (e.g., filters, etc.) shall be heated to a minimum of 120° F and a maximum of 250°F, which shall be monitored during the transient driving cycle.

(iii) CVS Compressor. The CVS compressor flow capacity shall be sufficient to maintain proper flow in the main CVS venturi with an adequate margin. For CFV CVSs the margin shall be sufficient to maintain choke flow. The capacity of the blower relative to the CFV flow capacity shall not be so large as to create a limited surge margin.

(iv) Materials. All materials in contact with exhaust gas shall be unaffected by and shall not affect the sample (i.e., the materials shall not react with the sample, and neither shall they taint the sample as a result of out gassing). Acceptable materials include stainless steel, Teflon®, silicon rubber, and Tedlar®.

(v) Alternative Approaches. Alternative CVS specifications, materials, or designs may be allowed upon a determination by the Administrator, that for the purpose of properly conducting an approved short test, the evidence supporting such deviations will not significantly affect the proper measurement of emissions.

(2) Sample System.

(i) Sample Probe. The sample probe within the CVS shall be designed such that a continuous and adequate volume of sample is collected for analysis. The system shall have a method for determining if the sample collection system has deteriorated or malfunctioned such that an adequate sample is not being collected, or that the response time has deteriorated such that the time correlation for each emission constituent is no longer valid.

(ii) CVS Mixing Tee.

(A) Design and Effect. The mixing tee for diluting the vehicle exhaust with ambient air shall be at the vehicle tailpipe exit as in §86.109-90(a)(2)(iv). The dilution mixing tee shall be capable of collecting exhaust from all light-duty vehicle and light-duty truck exhaust systems. The design used shall not cause static pressure in the tailpipe to change such that the emission levels are significantly affected. A change of ±1.0 inch of water, or less, shall be acceptable.

(B) Locating Device. The mixing tee shall have a device for positively locating the tee relative to the tailpipe with respect to distance from the tailpipe, and with respect to positioning the exhaust stream from the tailpipe(s) in the center of the mixing tee flow area. The locating device, or the size of the entrance to the tee shall be such that if a vehicle moves laterally from one extreme position on the dynamometer to the other extreme, that mixing tee will collect all of the exhaust sample.

(iii) Dual Exhaust. For dual exhaust systems, the design used shall insure that each leg of the sample collection system maintains equal flow. Equal flow will be assumed if the design of the "Tee" intersection for the dual CVS hoses is a "Y" that minimizes the flow loss from each leg of the "Y," if each leg of the dual exhaust collection system is approximately equal in length (± 1 foot), and if the dilution area at the end of each leg is approximately equal. In addition, the CVS flow capacity shall be such that the entrance flow velocity for each leg of the dual exhaust system is sufficient to entrain all of the vehicle's exhaust from each tailpipe.

(iv) Background Sample. The mixing tee shall be used to collect the background sample. The position of the mixing tee for taking the background sample shall be within 12 lateral and 12 longitudinal feet of the position during the transient driving cycle, and approximately 4 vertical feet from the floor.

(v) Integrated Sample. A continuous dilute sample shall be provided for integration by the analytical instruments in a manner similar to the method for collecting bag samples as described in §86.109.

(c) Analytical Instruments

(1) General Requirements.

(i) The emission analysis system shall automatically sample, integrate, and record the specified emission values for HC, CO, CO2, and NOx. Performance of the analytical instruments with respect to accuracy and precision, drift, interferences, noise, etc. shall be similar to instruments used for testing under §86 Subparts B, D, and N. Analytical instruments shall perform in this manner in the full range of operating conditions in the lane environment.

(ii) Alternative analytic equipment specifications, materials, designs, or detection methods may be allowed upon a determination by the Administrator, that for the purpose of properly conducting an approved short test, the evidence supporting such deviations will not significantly affect the proper measurement of emissions.

(2) Detection Methods and Instrument Ranges.

(i) Total Hydrocarbon Analysis. Total hydrocarbon analysis shall be determined by a flame ionization detector. If a 700 SCFM CVS is used, the analyzer calibration curve shall cover at least the range of 0 ppmC to 2,000 ppmC. Use of a different CVS flow capacity shall require an adjustment to these ranges. Appropriate documentation supporting any adjustment in ranges shall be available. Such documentation shall also address the ability of any altered ranges to accurately measure all cutpoints, including cutpoints for vehicles older than those specified in §85.2205(a), that may be used in the specific I/M program for which the altered ranges are proposed to be used. The calibration curve must comply with the quality control specifications in §85.2234(d) for calibration curve generation.

(ii) Carbon Monoxide Analysis. CO analysis shall be determined using a non-dispersive infrared analyzer. If a 700 SCFM CVS is used, CO analysis shall cover at least the range of 0 ppm to 10,000 ppm (1%). In order to meet the calibration curve requirements, two CO analyzers may be required - one from 0 to 1000 or 2000 ppm, and one from 0 to 1% CO. Use of a different CVS flow capacity shall require an adjustment to these ranges. Appropriate documentation supporting any adjustment in ranges shall be available. Such documentation shall also address the ability of any altered ranges to accurately measure all cutpoints, including cutpoints for vehicles older than those specified in §85.2205(a), that may be used in the specific I/M program for which the altered ranges are proposed to be used. The calibration curve requirements and the quality control specifications in §85.2234(d) apply to both analyzers.

(iii) Carbon Dioxide Analysis. CO_2 analysis shall be determined using an NDIR analyzer. If a 700 SCFM CVS is used, CO_2 analysis shall cover at least the range of 0 ppm to 40,000 ppm (4%). Use of a different CVS flow capacity shall require an adjustment to these ranges. Appropriate documentation supporting any adjustment in ranges shall be available. Such documentation shall also address the ability of any altered ranges to accurately measure all cutpoints, including cutpoints for vehicles older than those specified in §85.2205(a), that may be used in the specific I/M program for which the altered ranges are proposed to be used. The calibration curve must comply with the quality control specifications in §85.2234(d) for calibration curve generation.

(iv) Oxides of Nitrogen Analysis. NOx analysis shall be determined using chemiluminescense. The NOx measurement shall be the sum of nitrogen oxide and nitrogen dioxide. If a 700 SCFM CVS is used, the NOx analysis shall cover at least the range of 0 ppm to 500 ppm. Use of a different CVS flow capacity shall require an adjustment to these ranges. Appropriate documentation supporting any adjustment in ranges shall be available. Such documentation shall also address the ability of any altered ranges to accurately measure all cutpoints, including cutpoints for vehicles older than those specified in §85.2205(a), that may be used in the specific I/M program for which the altered ranges are proposed to be used. The calibration curve must comply with the quality control specifications in §85.2234(d) for calibration curve generation.

(3) System Response Requirements. The governing requirement for system response is the ability of the integration system to measure vehicle emissions to within ±5% of that measured from a bag sample simultaneously collected over the same integration period, on both clean and dirty vehicles. Historically, continuously integrated emission analyzers have been required to have a response time of 1.5 seconds or less to 90% of a step change, where a step change was 60% of full scale or better. System response times between a step change at the probe and reading 90% of the change have generally been less than 4 - 10 seconds. Systems proposed that exceed these historical values shall provide an engineering explanation as to why the slower system response of the integrated system will compare to the bag reading within the specified 5%.

(4) Integration Requirements.

(i) The analyzer voltage responses, CVS pressure(s), CVS temperature(s), dynamometer speed, and dynamometer power shall be sampled at a frequency of no less than 5 Hertz, and the voltage levels shall be averaged over 1 second intervals.

(ii) The system shall properly time correlate each analyzer signal and the CVS signals to the driving trace.

(iii) The one-second average analyzer voltage levels shall be converted to concentrations by the analyzer calibration curves. Corrected concentrations for each gas shall be derived by subtracting the pre-test background concentrations from the measured concentrations, according to the method in §85.2205(b). The corrected concentrations shall be converted to grams for each second using the equations specified in §85.2205(b) to combine the concentrations with the CVS flow over the same interval. The grams of emissions per test phase shall be determined using the equations in §85.2205(b).

(iv) When multiple analyzers are used for any constituent, the integration system shall simultaneously integrate both analyzers. The integrated values for the lowest analyzer in range shall be used for each second.

(v) For all constituents, the background concentration levels from the lowest range analyzer shall be used, including the case where multiple analyzers may have been used.

(5) Analytical System Design.

(i) Materials. All materials in contact with exhaust gas prior to and throughout the measurement portion of the system shall be unaffected by and shall not affect the sample (i.e., the materials shall not react with the sample, and neither shall they taint the sample as a result of out gassing). Acceptable materials include stainless steel, Teflon, silicon rubber, and Tedlar®.

(ii) Bag Ports. All analysis systems shall have provisions for reading a sample bag. A portable pump for sampling such bags is permitted.

(iii) System Filters. The sample system shall have an easily replaceable filter element to prevent particulate matter from reducing the reliability of the analytical system. The filter element shall provide for reliable sealing after filter element changes. If the sample line is heated, the filter system shall also be heated.

(iv) Availability of Intermediate Calculation Variables. Upon request prior to a test, all intermediate calculation variables shall be available to be downloaded to electronic files or hard copy. These variables shall include those that calculate the vehicle emission test results, perform emission analyzer and dynamometer function checks, and perform quality assurance and quality control measurements.

§85.2227 Evaporative System Inspection Equipment

(a) General Requirements

(1) Equipment Design. Automated and computerized test systems shall be used for the evaporative system tests. Pass/fail decisions shall be made automatically. The systems shall be tamper resistant and designed to avoid damage to the vehicle during installation, testing, and removal.

(2) Alternative Systems. Alternative purge or pressure test equipment, specifications, materials, or designs, may be proposed by a state and approved upon a determination by the Administrator that, for the purpose of properly conducting an approved short test, the evidence supporting such deviations will not appreciably or adversely affect the proper determination of system integrity, the proper measurement of purge, or the proper operation of the vehicle.

(b) Evaporative Purge System

(1) General Requirements. The evaporative purge analysis system shall measure the instantaneous purge flow in standard liters/minute, and shall compute the total volume of the flow in standard liters over the transient driving cycle.

(2) Specifications. The purge flow measuring system shall comply with the following requirements.

(i) Flow Capacity. A minimum of 50 liters per minute.

(ii) Pressure Drop. Maximum of 16 inches of water at 50 liters per minute for the complete system including hoses necessary to connect the system to the vehicle.

(iii) Totaled Flow. 0 to 100 liters of volume

(iv) Response Time. 410 milliseconds maximum to 90% of a step change between approximately 2 and 10 liters per minute measured with air.

(v) Accuracy.

(A) ±2.0 liters per minute between 10 and 50 liters per minute (rate)

(B) ±0.15 liters per minute between 0 and 10 liters per minute (rate)

(C) ±4% of 50 standard liters total flow volume between 10 and 50 liters total flow volume over one minute.

(D) ±1.5% of 10 standard liters between 0 and 10 liters total volume flow over one minute.

(vi) Noise. The maximum noise shall be less than 0.001 liters per second

(vii) Calibration Gas. Air

(3) Automatic Operation. Vehicle purge flow shall be monitored with a computerized system at a minimum sample rate of 1 Hz, shall automatically capture average (if sampled faster than 1 Hz) second-by-second readings, and shall automatically derive a pass/fail decision. In determining the total volume of flow, the monitoring system shall not count signal noise as flow volume. The test sequence shall be automatically initiated when the transient driving cycle test is initiated.

(4) Adaptability. The purge flow system shall have sufficient adapters to connect in a leak-tight manner with the variety of evaporative systems and hose deterioration conditions in the vehicle fleet. The purge measurement system shall not substantially interfere with purge flow.

(c) Evaporative System Pressure Test Equipment

(1) General Requirements.

(i) Pressure Gas. Nitrogen (N_2), or an equivalent non-toxic, non-greenhouse, inert gas, shall be used for pressurizing the evaporative system.

(ii) Automatic Operation. The process for filling the evaporative system, monitoring compliance, recording data, and making a pass/fail decision shall be automatic. After the determination that the evaporative system has been filled to the specified pressure level, and upon initiation of the test, the pressure level in the evaporative system shall be recorded at a frequency of no less than 1 Hertz until the conclusion of the test.

(iii) Test Abort. The system shall be equipped with an abort system that positively shuts off and relieves pressure. The abort system shall be capable of being activated quickly and conveniently by the inspector should the need arise.

(2) Adapters and Clamps.

(i) Canister Hose Adapters. The system shall have sufficient adapters to connect in a leak-tight manner with the variety of evaporative systems and hose deterioration conditions in the vehicle fleet.

(ii) Fuel Inlet Adapters. Fuel inlet adapters that fit on the vehicle's fuel inlet in a manner similar to the gas cap and designed to admit a pressurized source of gas into the fuel tank shall be used for the fuel inlet pressure test specified in §85.2222(d). Inlet specific adapters shall be available for at least 95 percent of the fuel inlets that are used on U.S. light duty vehicles and light duty trucks for the model years covered by the program. Varying internal volumes of the adapter assemblies shall not affect the accuracy of the test results. Adapters shall be made available within two years of the introduction of new model year vehicles.

(iii) Hose Clamp. The hose clamp used for the fuel inlet pressure test shall be designed to apply only enough pressure to close the hose without damaging it. The nose of the clamp shall be smooth-surfaced or otherwise designed to avoid abrasion of the vehicle hose.

(3) Pressure Gauge. The device for measuring pressure in the vehicle's evaporative system shall have a minimum range of 0 to 50 inches of water and an accuracy of ±0.3 inches of water (2% of 15) or better.

(4) Flow Meter. A flow meter with a range of at least 0 to 10 liters per minute and ±5% accuracy shall be used for the measurement of flow.

(5) Gas Cap Tester. The tester shall provide a visual or digital signal that the required air supply pressure is within the acceptable range and the flow comparison test is ready to be conducted. The tester shall incorporate an upstream maintainable filter. If the tester is battery powered, it must be equipped with an automatic shutoff and a low-battery indicator. A NIST traceable reference passing fuel cap of nominal 52-56 cubic centimeters per minute, and a NIST traceable reference failing fuel cap of nominal 64-68 cubic centimeters per minute shall be supplied with the tester for daily test verification. Leak rate measurements shall be accurate to ±3 cubic centimeters per minute.

(6) Flow Standard. The flow standard shall be a square edged circular orifice with a NIST traceable flow rate which in combination with the comparison circuitry will produce a pass/fail threshold of 60 cubic centimeters at 30 inches of water column. Transducers used in the comparison circuitry shall have accuracy traceable to NIST. The supply pressure may be obtained using room air and any convenient low pressure source. The tester shall control the supply pressure and prevent over pressurization.

§85.2234 IM240 Test Quality Control Requirements

(a) General Requirements

(1) Minimums. The frequency and standards for quality control specified here are minimum requirements, unless modified as specified in §85.2234(2). Greater frequency or tighter standards may be used as needed.

(2) Statistical Process Control. Reducing the frequency of the quality control checks, modifying the procedure or specifications, or eliminating the quality control checks altogether may be allowed if the Administrator determines, for the purpose of properly conducting an approved short test, that sufficient Statistical Process Control (SPC) data exist to make a determination, that the SPC data support such action, and that taking such action will not significantly reduce the quality of the emission measurements. Should emission measurement performance or quality deteriorate as a result of allowing such actions, the approval shall be suspended, and the frequencies, procedures, specifications, or checks specified here or otherwise approved shall be reinstated, pending further determination by the Administrator.

(3) Modifications. The Administrator may modify the frequency and standards contained in this section if found to be impractical.

(b) Dynamometer

(1) Coast Down Check.

(i) The calibration of each dynamometer shall be checked on a weekly basis by a dynamometer coast-down equivalent that in §86.118-78 (for reference see EOD Test Procedures TP-302A and TP-202) between the speeds of 55 to 45 mph, and between 22 to 18 mph. All rotating dynamometer components shall be included in the coast-down check for the inertia weight selected.

(ii) The base dynamometer and the base plus each prime inertia weight flywheel, if any, shall be checked with at least two horsepower settings within the normal range of the inertia weight. For dynamometers that use electrical inertia simulation and have a base inertia outside of the range of 3000 pounds to 4500 pounds, the coast-down check shall be conducted with at least two horsepower settings at the base inertia, and two settings at either 2500 pounds or 4500 pounds, whichever is furthest from the base inertia weight. For both mechanical flywheel dynamometers and electrical inertia simulation dynamometers, the horsepower settings selected shall correspond to a vehicle / engine category that matches the inertia weight selected for the coast-down test. Where the base inertia, or the base inertia plus the smallest flywheel results in a coast-down inertia of less than 2250 pounds, only one horsepower setting is required for the check.

(iii) The coast-down procedure shall use a vehicle off-dynamometer type method or equivalent. 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 on the 55 to 45 mph coast-down as calculated by §85.2234(b)(1)(iii)(A) or (B), official testing shall automatically be prevented, and corrective action shall be taken to bring the dynamometer into calibration. Official testing shall also automatically be prevented, and corrective action shall be taken to bring the dynamometer into calibration, if the difference between the measured coast-down time and the theoretical coast-down time for 22 to 18 mph is outside of the time window calculated by §85.2234(b)(1)(iii)(C) or (D). For tests using inertia weights of 8500 lbs. and above, if the difference between the measured coast-down time and the theoretical coast-down time is outside of the time window calculated by §85.2234(b)(1)(iii)(C) or (D) for the 22 mph to the 18 mph coast-down when substituting 0.27 HP for the allowable force-error (equivalent to 5.0 pounds-force at 20 mph), official testing shall automatically be prevented, and corrective action shall be taken to bring the dynamometer into calibration.

(A) The off-dynamometer target coast-down time at 50 mph ($DET_{@50\ mph\text{-}8}$) for dynamometers with 8.265 inch rolls shall be calculated as follows.

$$DET_{@50mph\text{-}8} = \frac{\left(\frac{0.5 * ETW}{32.2}\right) * (V_{55}^2 - V_{45}^2)}{550 * (TRLHP_{@50mph} - GTRL_{@50mph\text{-}8})}$$

(B) The off-dynamometer target coast-down time at 50 mph ($DET_{@50\ mph\text{-}20}$) for dynamometers with 20.0 inch rolls shall be calculated as follows.

$$DET_{@50mph\text{-}20} = \frac{\left(\frac{0.5 * ETW}{32.2}\right) * (V_{55}^2 - V_{45}^2)}{550 * (TRLHP_{@50mph} - GTRL_{@50mph\text{-}20})}$$

(C) The maximum and minimum time limits for the off-dynamometer coast-down window at 20 mph ($DT_{Max\ @\ 20\ mph\text{-}8}$, $DT_{Min\ @\ 20\ mph\text{-}8}$) for dynamometers with 8.265 inch rolls shall be calculated by the following equations. The TRLHP and GTRL used in these calculations shall be determined from the same vehicle / engine category used to determine the 50 mph off-dynamometer target coast-down time. If the calculated maximum value ($DT_{Max\ @\ 20\ mph\text{-}8}$) exceeds twice the target value calculated for a specific vehicle / engine category ($DT_{Ave\ @\ 20\ mph\text{-}8}$), or if the maximum value is a negative number, a value equal to twice the target value shall be substituted for the maximum time limit.

$$DT_{Max@20mph-8} = \frac{\left(\frac{0.5*ETW}{32.2}\right)*(V_{22}{}^2-V_{18}{}^2)}{550*(TRLHP_{@20mph}-GTRL_{@20mph-8}-0.17HP)}$$

$$DT_{Ave@20mph-8} = \frac{\left(\frac{0.5 * ETW}{32.2}\right) * (V_{22}{}^2 - V_{18}{}^2)}{550*(TRLHP_{@20mph}-GTRL_{@20mph-8})}$$

$$DT_{Min@20mph-8} = \frac{\left(\frac{0.5*ETW}{32.2}\right)*(V_{22}{}^2-V_{18}{}^2)}{550*(TRLHP_{@20mph}-GTRL_{@20mph-8}+0.17HP)}$$

(D) The maximum and minimum time limits for the off-dynamometer coast-down window at 20 mph ($DT_{Max\ @\ 20\ mph-20}$, $DT_{Min\ @\ 20\ mph-20}$) for dynamometers with 20.0 inch rolls shall be calculated by the following equations. The TRLHP and GTRL used in these calculations shall be determined from the same vehicle / engine category used to determine the 50 mph off-dynamometer target coast-down time.

$$DT_{Max@20mph-20} = \frac{\left(\frac{0.5*ETW}{32.2}\right)*(V_{22}{}^2-V_{18}{}^2)}{550* (TRLHP_{@20mph}-GTRL_{@20mph-20}-0.17HP)}$$

$$DT_{Min@20mph-20} = \frac{\left(\frac{0.5*ETW}{32.2}\right)*(V_{22}{}^2-V_{18}{}^2)}{550*(TRLHP_{@20mph}-GTRL_{@20mph-20}+0.17HP)}$$

(E) Where:

$DET_{@\ 50\ mph-dd}$ = Off-dynamometer target coast-down time (seconds) at 50 mph for a dynamometer with a roll diameter corresponding to the designator "dd"

$DT_{Max\ @\ 20\ mph-dd}$ = Upper off-dynamometer target coast-down time limit (seconds) at 20 mph for a dynamometer with a roll diameter corresponding to the designator "dd"

$DT_{Ave\ @\ 20\ mph-dd}$ = Off-dynamometer target coast-down time (seconds) at 20 mph for a dynamometer with a roll diameter corresponding to the designator "dd"

$DT_{Min\ @\ 20\ mph-dd}$ = Lower off-dynamometer target coast-down time limit (seconds) at 20 mph for a dynamometer with a roll diameter corresponding to the designator "dd"

$TRLHP_{@\ 50\ mph}$ = Track Road Load Horsepower at 50 mph for a specific vehicle engine category selected for the coast down check.

$TRLHP_{@\ 20\ mph}$ = Track Road Load Horsepower at 20 mph for the corresponding specific vehicle engine category selected for the 50 mph coast down check.

$GTRL_{@\ 50\ mph\text{-}dd}$ = Generic Tire/Roll Horsepower loss at 50 mph for a dynamometer with "dd" roll size, and corresponding to the specific vehicle engine category selected for the 50 mph coast down check.

$GTRL_{@\ 20\ mph\text{-}dd}$ = Generic Tire/Roll Horsepower loss at 20 mph for a dynamometer with "dd" roll size, and corresponding to the specific vehicle engine category selected for the 50 mph coast down check.

ETW = Equivalent Test Weight (i.e., inertia weight) in pounds corresponding to the specific vehicle engine category selected for the 50 mph coast down check.

V_{xx}^2 = Velocity in feet per second corresponding to the mph value "xx"

0.17 HP = Horsepower representation of an allowable force-error of 3.3 pounds-force at 20 mph. This allowable force-error is approximately equivalent to a ± 2 second tolerance in the off-dynamometer target coast-down time at 50 mph for a dynamometer with 8.625" rolls when using a TRLHP computed from the EPA on-dynamometer target coast-down time. This force-error is approximately equivalent to a ± 1.25 second tolerance in the off-dynamometer target coast-down time at 50 mph for a dynamometer with 20.0" rolls.

(iv) The clock used to check the coast-down time shall be accurate to 0.1 percent of reading between 10 and 1000 seconds with a resolution of 0.01 seconds.

(v) The results of each dynamometer coast-down check performed shall be automatically computed and recorded on electronic media with a date and time stamp.

(2) Roll Speed. Roll speed and roll counts shall be checked each operating day by an independent means (e.g., photo tachometer). Deviations of greater than ±0.2 mph or a comparable tolerance in roll counts shall require corrective action. Alternatively, a redundant roll speed transducer independent of the primary

transducer may be used in lieu of the daily comparison. Accuracy of redundant systems shall be checked monthly.

(3) Warm-Up. Dynamometers shall be in a warmed up condition for use in official testing. Warm-up is defined as sufficient operation that allows the dynamometer to meet the coast down time (within 3 seconds) identified for the specific dynamometer during calibration. The reference coast-down time shall be the value for 55 to 45 mph with the lightest inertia weight and lowest horsepower for that weight used during weekly calibrations. Alternatively, the reference coast-down time shall be the value for 22 to 18 mph with the lightest inertia weight and lowest horsepower for that weight used during weekly calibration, with a time standard of ±20%. Warm-up may be checked by comparing the measured parasitic losses at least 25 mph to reference values established during calibration.

(4) Acceptance Testing. Upon initial installation and prior to beginning official testing, the performance of each dynamometer and dynamometer design shall be verified for compliance with the requirements in §85.2226(a). Specific acceptance verification requirements are described in §85.2234(b)(4)(i) through §85.2234(b)(4)(v).

(i) Coast Down / Vehicle Loading Check Following Installation. The coast down performance of each dynamometer shall be checked to verify the ability of the dynamometer and dynamometer load setting system to meet dynamometer target coast down times prior to beginning official testing. The performance shall be checked by the procedure defined in §85.2234(b)(4)(i)(A) through §85.2234(b)(4)(i)(J), or by a comparable procedure acceptable to the Administrator.

(A) The dynamometer shall be warmed-up by the dynamometer manufacturer's procedure.

(B) At least three vehicle / engine categories shall be selected from the EPA Look-Up table for vehicle loading. The vehicle / engine categories should cover the range of expected test vehicles. If look-up table data is not available at the time of acceptance testing, TRLHP values can be selected from the table of default values in §85.2221 (c)(5). If default TRLHP values are used, drive-axle weight (DAXWT) shall be computed as 46.0 percent of the test inertia weight in the table for 2250 pounds and above. A value of 63 percent of the test inertia weight in the table shall be used for 2249 pounds and below.

(C) The dynamometer shall be set for the first vehicle/engine category selected based on the variables used to uniquely index the vehicle engine category (e.g., model year, manufacturer, model, number of cylinders, engine size, and transmission type).

(D) The dynamometer shall be coasted down from 65 mph to 5 mph with the settings pre-selected in §85.2234(b)(4)(i)(C).

(E) The 55 mph to 45 mph, and the 22 mph to 18 mph coast down times shall be recorded for the data collected in §85.2234(b)(4)(i)(D).

(F) The dynamometer shall be coasted down from 65 mph to 5 mph after having been adjusted for each of the other two vehicle engine categories, and the 55 mph to 45 mph, and the 22 mph to 18 mph coast down times shall be recorded for each coast-down.

(G) The coast-downs specified in §85.2234(b)(4)(i)(C) through §85.2234 (b)(4)(i)(F) shall be replicated for a total of three coast-down tests for each vehicle inertia category. The replications of the coast-downs for each vehicle engine category shall be run in random sequence.

(H) The off-dynamometer target coast-down time at 50 mph ($DET_{@\ 50\ mph\text{-}dd}$) for each vehicle / engine category shall be calculated as specified in §85.2234(b)(1)(iii)(A) or (B) for the applicable dynamometer roll size.

(I) The upper and lower off-dynamometer coast-down time limits at 20 mph ($DT_{Max\ @\ 20\ mph\text{-}dd}$, $DT_{Min\ @\ 20\ mph\text{-}dd}$) for each vehicle / engine category shall be calculated as specified in §85.2234(b)(1)(iii)(C) or (D) for the applicable dynamometer roll size.

(J) The dynamometer vehicle loading is considered acceptable if each measured 55 mph to 45 mph coast-down time for each vehicle / engine category tested is within ±1 second of the off-dynamometer target coast-down time determined in (b)(4)(i)(H) above, and if each measured 22 mph to 18 mph coast-down time for each vehicle / engine category tested is within the off-dynamometer target coast-down time limits determined in (b)(4)(i)(I) above.

(ii) Vehicle Loading Check of Dynamometer Design. For each dynamometer design used, the I/M Program Office shall obtained and maintain a report verifying the ability of the dynamometer design to properly load vehicles as specified in §85.2226(a). The dynamometer manufacturer may prepare the report. The report shall identify how each requirement in §85.2226(a) is performed by the specific dynamometer design used. In addition, where specific performance levels or characterizations are specified {e.g., §85.2226 (a)(2)(viii), §85.2226(2)(x), §85.2226(4)(ii) and §85.2226(a)(5)}, test data with supporting analysis verifying compliance shall be included. At a minimum, the test data shall include a comparison and analysis of the expected coast-down times versus the actual vehicle on-dynamometer coast-down times for at least three vehicles spanning the range of drive axle weights and horsepower. Actual track coast-down data and curves shall be available for the makes and models of vehicles selected from which the expected coast-down times shall be derived. The analysis shall also graphically compare the track horsepower curves to curves generated from the on-dynamometer coast-down testing. Reasons for variations in time, equivalent to one horsepower, between the expected coast-down times and the actual vehicle on-dynamometer coast-down times, or variations between the curves of more than one horsepower shall be explained in the report.

(iii) Alternative Coast Down / Vehicle Loading Check. This procedure may be used in lieu of the procedures in §85.2234(b)(4)(i). The coast down performance of each dynamometer shall be checked with at least two categories of vehicles to verify the ability of the dynamometer and dynamometer load setting system to meet dynamometer target coast down times. The coast down performance of each dynamometer design used shall be checked with at least 6 categories of vehicles to determine the ability of the dynamometer design to properly load the vehicle over the required speed range as defined in §85.2226(a)(2). The performance of the design shall be checked by the procedure defined §85.2234(b)(4)(ii)(A) through §85.2234(b)(4)(ii)(L), or by a comparable procedure acceptable to the Administrator.

(A) The dynamometer shall be warmed-up by the dynamometer manufacturer's procedure, and the tires and drive train on the test car shall be warmed-up by operating the vehicle at 50 mph for 20 minutes. The tire pressure in the test vehicles shall be at 45 psi.

(B) The dynamometer indicated power (IHP) and inertia weight for the vehicle shall be selected for the test vehicle.

(C) The test vehicle shall be coasted down from 65 mph to 5 mph on the dynamometer with the settings pre-selected in §85.2234(b)(4)(i)(B).

(D) The 55 mph to 45 mph, and the 22 mph to 18 mph coast down times shall be recorded for the data collected in §85.2234(b)(4)(i)(C).

(E) The test vehicle shall again be coasted down from 65 mph to 5 mph on the dynamometer with the dynamometer power absorber reset to a load of zero.

(F) A speed versus horsepower equation of the form in §85.2226(a)(2)(iii) shall be determined for the data collected in §85.2234(b)(4)(i)(E).

(G) The test vehicle shall be removed from the dynamometer, and the dynamometer shall be coasted down from 65 mph to 5 mph with the dynamometer power absorber set to a load of zero.

(H) A speed versus horsepower equation of the form in §85.2226(a)(2)(ix) for parasitic losses (PLHP) shall be determined for the data collected in §85.2234(b)(4)(i)(G).

(I) The tire/roll interface losses shall be determined by subtracting the horsepower curve determined in §85.2234(b)(4)(i)(H) from the horsepower curve determined in §85.2234(b)(4)(i)(F). The tire loss curve (GTRL) shall be in the form specified in §85.2226(a)(2)(xiii).

(J) Repeat the steps in §85.2234(b)(4)(i)(B) through §85.2234(b)(4)(i)(I) to obtain a total of three sets of data for each test vehicle. The dynamometer and vehicle may be warmed-up as needed to meet the requirements in §85.2234(b)(4)(i)(A).

(K) For each test vehicle, compute the average 55 mph to 45 mph coast down time, the average 22 mph to 18 mph coast down time, and the average tire/roll interface loss curve as measured in §85.2234(b)(4)(i)(B) through §85.2234(b)(4)(i)(J).

(L) The dynamometer vehicle loading is considered acceptable if, for each test vehicle, the average values determined in §85.2234(b)(4)(i)(K) are within ±1 second of the 55 mph to 45 mph for the target time specified in §85.2226(a)(2)(ii), are within ±7 percent of the 22 mph to 18 mph that is calculated from §85.2226(a)(2)(iii) and §85.2226(a)(2)(iv), and within ±15 percent of a generic tire/roll loss curve for the category of vehicle.

(iv) Load Measuring Device Check. The load measuring device on each dynamometer shall be checked by a dead-weight method (or equivalent) at least six points across the range of loads used for vehicle testing. Physical checking weights shall be traceable to NIST standards to within ± 0.5 percent. Equivalent methods shall document the method used to verify equivalent accuracy. The accuracy of the interpreted value used for calculation or control shall be within ±1 percent of full scale.

(v) Vehicle Inertia Loading. The actual inertia applied to the vehicle by each inertia weight, in combination with the base inertia, shall be verified for each dynamometer to insure compliance with the requirements in §85.2226(a)(4)(i) or §85.2226(a)(4)(ii) as applicable.

(vi) Parasitic loss check between 8 and 12 mph. The coast down time of each dynamometer between 8 and 12 mph shall be verified for compliance with the requirements of §85.2226(a)(2)(x).

(vii) Speed and Distance Check. The performance of the speed and distance measuring system of each dynamometer shall be verified for compliance with the requirements of §85.2226(a)(5)(i). The ability to resolve acceleration as specified in §85.2226(a)(5)(i) need only be generically verified for the design used. If more than one design is used, each design shall be verified.

(viii) Warm-up System Check. The dynamometer warm-up system shall be checked for compliance with the requirements in §85.2234(b)(3) by conducting a coast down check immediately following completion of the warm-up specified by the dynamometer manufacturer or the system. The design of the warm-up system should be checked across the range of temperatures experience in-use, and particularly at the lower speeds.

(5) Coast-down Times. Following acceptance, 55 to 45 mph, and 22 to 18 mph coast-down times shall be determined for quality control purposes with the vehicle off the dynamometer for each inertia weight and for at least 2 horsepower settings within the normal range of the inertia weight as required in §85.2234(b)(1)(ii). These quality control values shall be determined when the dynamometer has been set to meet either the coast-down target times with the vehicle on the dynamometer (i.e., 55 to 45 mph and 22 to 18 mph), or the equation coefficients. The I/M program manager, may however, select different vehicle/engine categories to check coast-down times as in §85.2234(b)(4)(i) for audit purposes.

(c) Constant Volume Sampler

(1) Flow Calibration. The flow of the CVS shall be calibrated at six flow rates upon initial installation, 6 months following installation, and every 12 months thereafter. The flow rates shall include the nominal rated flow-rate and a rate below the rated flow-rate for both critical flow venturis and subsonic venturis, and a flow-rate above the rated flow for sub-sonic venturis. The flow calibration points shall cover the range of variation in flow that typically occurs when testing. A complete calibration shall be performed following repairs to the CVS that could affect flow.

(2) System Check. CVS flow calibration at the nominal CVS design flow shall be checked once per operating day using a procedure that identifies deviations in flow from the true value. A procedure equivalent to that in §86.119(c) shall be used. Deviations greater than ±4% shall result in automatic lockout of official testing until corrected.

(3) Cleaning Flow Passages. The sample probe shall be checked at least once per month and cleaned if necessary to maintain proper sample flow. CVS venturi passages shall be checked once per year and cleaned if necessary.

(4) Probe Flow. The indicator identifying the presence of proper probe flow for the system design (e.g., proportional flow for CFV systems, minimum flow for time correlation of different analyzers) shall be checked on a daily basis. Lack of proper flow shall require corrective action.

(5) Leak Check. The vacuum portion of the sample system shall be checked for leaks on a daily basis and each time the system integrity is violated (e.g., changing a filter).

(6) Bag Sample Check. On a quarterly basis, vehicle exhaust shall be collected in sample bags with simultaneous integrated measurement of the sample. At least one bag each for Phase 1 and for Phase 2 of the transient test cycle shall be conducted. Differences between the two measurement systems greater than 10% shall result in

system lockout until corrective action is taken. For the purposes of acceptance testing, the differences shall be no greater than 5%.

(7) Response Time Check. The response time of each analyzer shall be checked upon initial installation, during each check for compliance with §85.2234(c)(6), after each repair or modification to the flow system that would reasonably be expected to affect the response time, and at least once per week. The check shall include the complete sample system from the sample probe to the analyzer. Statistical process control shall be used to monitor compliance and establish fit for use limits based on the requirements in §85.2226(c). At a minimum, response time measurements that deviate significantly from the average response time for all CVS systems designed to the same specification in the program shall require corrective action before testing may resume.

(8) Mixing Tee Acceptance Test.

(i) The design of the mixing tee shall be evaluated by running the transient driving cycle on at least two vehicles, representing the high and low ends of engine displacement and inertia. Changes in the static tailpipe pressure with and without CVS, measured on a second-by-second basis within 3 inches of the end of the tailpipe, shall not exceed ±1.0 inch of water.

(ii) The ability of the mixing tee design to capture all of the exhaust as a vehicle moves laterally from one extreme position on the dynamometer to the other extreme shall be evaluated with back-to-back testing of three vehicles, representing the high and low ends of engine displacement and inertia. The back-to-back testing shall be done with the mixing tee at the tailpipe and with an airtight connection to the tailpipe (i.e., the mixing tee will be effectively moved downstream, as in typical FTP testing). The difference in carbon-balance fuel economy between the mixing tee located at the vehicle and the positive connection shall be no greater than 5%.

(iii) The design of the dual exhaust system shall be evaluated with back-to-back testing of three vehicles, representing the high and low ends of engine displacement and inertia, with an airtight connection to the tailpipe (i.e., the mixing tee will be effectively moved downstream, as in typical FTP testing, for these qualification tests). The difference in carbon-balance fuel economy between the two methods shall be no greater than 5%.

(d) Analysis System

(1) Calibration Curve Generation.

(i) Upon initial installation, calibration curves shall be generated for each analyzer. If an analyzer has more than one measurement transducer, each transducer shall be considered as a separate analyzer in the analysis system for the purposes of curve generation and analysis system checks.

(ii) The calibration curve shall consider the entire range of the analyzer as one curve.

(iii) At least 5 calibration points plus zero shall be used in the lower portion of the analyzer range corresponding to an average concentration of approximately 2 gpm for HC, 30 gpm for CO, 3 gpm for NOx, and 400 gpm for CO_2. When both a low range analyzer and a high range analyzer are used for a single interest gas (e.g., CO), the high range analyzer shall use at least 5 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 5 calibration points shall be used to define the calibration curve above the 5 lower calibration points. The calibration zero gas shall be used to set the analyzer to zero.

(iv) Gas dividers may be used to obtain the intermediate points for the general range classifications specified.

(v) The calibration curves generated shall be a polynomial of the best fit and no greater than 4^{th} order, and shall fit the data within 2.0% at each calibration point as specified in §86.121-90, §86.122-78, §86.123-78, and §86.124-78. An exception to the 2% fit may be allowed with approval by the Administrator if supported by appropriate data for the lowest two non-zero calibration points, provided that those points are below a value corresponding to an average concentration of approximately 1 gpm for HC, 15 gpm for CO, 1.5 gpm for NOx, and 200 gpm for CO_2. For those points the allowable curve fit may be increased to no more than 5%. (For reference, see EPA NVFEL Procedure No. 204)

(vi) Each curve shall be verified for each analyzer with a confirming calibration standard between 40-80% of full scale that is not used for curve generation. Each confirming standard shall be measured by the curve within 2.5%.

(2) Spanning Frequency. The zero and up-scale span points shall be checked at 2 hour intervals following the daily mid-scale curve check specified in §85.2234(d)(4) and adjusted if necessary. If the up-scale span point drifts by more than 2.0% from the previous check or, for the first check performed after the daily calibration check described in §85.2234(d)(4), from the daily check official testing shall be prevented and corrective action shall be taken to bring the system into compliance. If the zero point drifts by more than 2 ppmC HC, 1 ppm NOx, 10 ppm CO, or 40 ppm CO2, official testing shall be prevented and corrective action shall be taken to bring the system into compliance. Or, the unit may be zeroed prior to each test.

(3) Limit Check. The tolerance on the adjustment of the up-scale span point shall be 0.4% of point. A software algorithm to perform the zero and span adjustment and subsequent calibration curve adjustment shall be used. Cumulative software up-scale zero and span adjustments greater than ±10% from the latest calibration curve shall cause official testing to be prevented and corrective action shall be taken to bring the system into compliance.

(4) Daily Calibration Checks. The curve for each analyzer shall be checked and adjusted to correctly read zero using a working zero gas, and an up-scale span gas within the tolerance in §85.2234(d)(3), and then by reading a mid-scale span gas within 2.5% of point, on each operating day prior to vehicle testing. If the analyzer does not read the mid-scale span point within 2.5% of point, the analyzer shall automatically be prevented from official testing. The up-scale span gas concentration for each analyzer shall correspond to approximately 80% of full scale, and the mid-point concentration shall correspond to approximately 15% of full scale.

(5) Weekly NOx Convertor Checks. The convertor efficiency of the NO_2 to NO convertor shall be checked on a weekly basis. The check shall be equivalent to §86.123-78 (for reference see EOD Form 305-01) except that the concentration of the NO gas shall be in the range of 100-300 ppm. Alternative methods may be used if approved by the Administrator.

(6) Weekly NO/NOx Flow Balance. The flow balance between the NO and NOx test modes shall be checked weekly. The check may be combined with the NOx convertor check as illustrated in EPA NVFEL Form 305-01.

(7) Monthly Calibration Checks. The basic calibration curve shall be verified monthly by the same procedure used to generate the curve in §85.2234(d)(1), and to the same tolerances.

(8) FID Check.

(i) Upon initial operation, and after maintenance to the detector, each FID shall be checked, and adjusted if necessary, for proper peaking and characterization using the procedures described in SAE Paper No. 770141 or by analyzer manufacturer recommended procedures.

(ii) The response of each FID to a methane concentration of approximately 50 ppm CH_4 shall be checked once per month. If the response is outside of the range of 1.00 to 1.30, corrective action shall be taken to bring the FID response within this range. The response shall be computed by the equation in §85.2234(d)(9)(iii).

(iii) $$\text{Ratio of Methane Response} = \frac{\text{FID response in ppmC}}{\text{ppm } CH_4 \text{ in cylinder}}$$

(9) Integrator Checks. Upon initial operation, and every three months thereafter, emissions from a vehicle with transient cycle test values between 60% and 400% of the 1984 LDGV standard 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 between the integrator and bag readings exceeding ±10% shall require corrective action.

(10) Cross-Checks. On a quarterly basis, and whenever gas bottles are changed, each analyzer in a given facility shall analyze a sample of a test gas. The test gas shall be independent of the gas used for the daily calibration check in §85.2234(d)(4), in independent bottles. The same test gas, or gas mixture shall be used for all analyzers. The concentration of the gas shall be one of three values corresponding to approximately 0.5 to 3 times the cutpoint (in gpm) for 1984 and later model year vehicles for the constituent. One of the three values shall be at the lower end of the range, another shall be at the higher end of the range, and the other shall be near the middle of the range. The values selected shall be rotated in a random manner for each cross-check. The value of the checking sample may be determined by a gas divider. The deviation in analysis from the concentration of the checking sample 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 be placed out of service.

(11) Interference -- Laboratory Testing. The design of each CO, CO_2, and NOx analyzer shall be checked for water vapor interference prior to initial service. The interference limits in this paragraph shall apply to analyzers used with a CVS of 700 SCFM or greater. For analyzers used with lower flow rate CVS units, the allowable interference response shall be proportionately adjusted downward.

(i) CO Analyzer. A gas mixture of 4% CO_2 in N_2 bubbled through water with a saturated-mixture temperature of 40°C shall produce a response on the CO analyzer of no greater than 15 ppm at 40°C. Also, a gas mixture of 4 percent CO_2 in N_2 shall produce a response on the CO analyzer of no greater than 10 ppm at 40°C.

(ii) CO2 Analyzer. A calibration zero gas bubbled through water with a saturated-mixture temperature of 40°C shall produce a response on the CO_2 analyzer of no greater than 60 ppm.

(iii) NOx Analyzer. A calibration zero gas bubbled through water with a saturated-mixture temperature of 40°C shall produce a response on the NOx analyzer of no greater than 1 ppm. Also, a gas mixture of 4 percent CO2 in either N2 or air shall produce a response on the NOx analyzer of no greater than 1.0 ppm at 40°C.

(12) Interference -- Field Testing. Each CO, CO_2, and NOx analyzers shall be checked for water vapor interference prior to initial service, and on a yearly basis thereafter. The in-field check prior to initial service and the yearly checks shall be performed on a high ambient temperature summer day (or simulated conditions). For analyzers used with lower flow rate CVS units, the allowable interference response shall be proportionately adjusted downward. The allowable interference level shall be adjusted to coincide with the saturated-mixture temperature used. For the CO analyzer, a rejection ratio of 9,000 to 1 shall be used for this calculation. A ratio of 2000 to 1 shall be used for CO_2 analyzers. A ratio of 90,000 to 1 shall be used for NOx analyzers.

(e) Gases

(1) General Requirements. Gas blends may contain up to three of any of the following components: HC , CO, CO2, and NO. The HC component shall be propane. The diluent for blends containing HC shall be air. The diluent for blends containing NO shall be N2. CO and CO2 may be used with either air or N2 as the diluent. Blends containing four interest components may be used only if approved by the Administrator. Blends containing NO2 shall also require approval by the Administrator prior to use, except if used to perform the NOx converter check specified in §85.2234(d)(5). Any interference effects between components in a gas blend shall be addressed in the quality control and quality assurance process. When a gas audit of the analytical system is performed, the auditor shall indicate whether CO2 is present in the audit gas mixture prior to performing the audit.

(2) Calibration Gases. Gases used to generate and check calibration curves shall be traceable to a NIST SRM, CRM, NTRM, or RGM and have a stated uncertainty to within 1% of the standard by Gas Comparison methods. Calibration zero gas shall be used when using a gas divider to generate intermediary calibration gases.

(3) Span Gases. Gases used for up-scale span adjustment, cross-checks, and for mid-scale span checks shall be traceable to NIST SRM, CRM, NTRM, or RGM and have a stated uncertainty to within 2% of the standard by Gas Comparison methods. Span gas concentrations shall be verified immediately after a monthly calibration curve check and before being put into service. If the reading on the span gases exceeds 2.5% of the label value, the system or gases shall be taken out of service until corrective action is taken. When a gas divider is used to generate span gases, the diluent gas shall not have impurities any greater than the working zero gas.

(4) Calibration Zero Gas. The impurities in the calibration zero gas shall not exceed 0.1 ppmC, 0.5 ppm CO, 1 ppm CO2, and 0.1 ppm NO. Calibration zero grade air shall be used for the FID zero calibration gas. Calibration zero grade nitrogen or calibration zero grade air shall be used for CO, CO2, and NOx zero calibration gases.

(5) Working Zero Gas. The impurities in working zero grade gases shall not exceed 1 ppmC, 2 ppm CO, 400 ppm CO2, and 0.3 ppm NOx. Working zero grade air or calibration zero grade air shall be used for the FID zero span gas. Working or calibration zero grade nitrogen or air shall be used for CO, CO2, and NOx zero span gases.

(6) FID Fuel. The fuel for the FID shall consist of a mixture of 40% (±2%) hydrogen, and the balance helium. The FID oxidizer shall be zero grade air, which can consist of artificial air containing 18 to 21 mole percent of oxygen.

(7) Gas Naming Protocol. Gases used for calibration or auditing shall be named according to a written established practice that has been approved by the Administrator.

(f) Overall System Performance

(1) Emission Levels. For each test lane, the average, median, 10^{th} percentile and 90^{th} percentile of the composite emissions (HC, CO, CO_2, and NOx) measured shall be monitored on a monthly basis. Differences in the monthly average of greater than ±10% by any one lane from the facility-average or combined facility-average, or by any one facility from the combined facility-average shall require an investigation to determine whether the single lane or facility has a systematic equipment or operating error or difference. Where it can be determined that the averages from one facility (or facilities) are offset from the average of the other facilities based on the mix of vehicles tested, the ±10% limit shall be compared to the expected offset. If systematic equipment or operating errors or differences causing the offset are found, such errors shall be corrected. The sample period may be adjusted to assure that a reasonably random sample of vehicles was tested in each lane.

(2) Pass/Fail Status. The average number of passing vehicles and the average number of failing vehicles shall be monitored monthly for each test lane. Differences in the monthly average of greater than ±15% by any one lane from the facility-average or combined facility-average, or by any one facility from the combined facility-average shall require an investigation to determine whether the single lane or facility has a systematic equipment or operating error or difference. Where it can be determined that the averages from one facility (or facilities) are offset from the average of the other facilities based on the mix of vehicles tested, the ±15% limit shall be compared to the expected offset. If systematic equipment or operating errors or differences causing the offset are found, such errors shall be corrected. The sample period may be adjusted to assure that a reasonably random sample of vehicles was tested in each lane.

(g) Control Charts

(1) General Requirements. Control charts and Statistical Process Control theory shall be used to determine, forecast, and maintain performance of each test lane, each facility, and all facilities in a given network. The control charts shall cover the performance of key parameters in the test system. When key parameters approach control chart limits, close monitoring of such systems shall be initiated and corrective actions shall be taken when needed to prevent such systems from exceeding control chart limits. If any key parameter exceeds the control chart limits, corrective action shall be taken to bring the system into compliance. The control chart limits specified are those values listed for the test procedures, the equipment specifications, and the quality control specifications that cause a test to be voided or require equipment to be removed from service. These values are "fit for use" limits, unlike a strict interpretation of SPC control chart theory which may use tighter limits to define the process. The test facility is encouraged to apply SPC strict control chart theory to determine when equipment or processes could be improved. No action shall be required until the equipment or process exceeds the "fit for use limits" specified in this section.

(2) Control Charts for Individual Test Lanes. In general, control charts for individual test lanes shall include parameters that will allow the cause for abnormal performance of a test lane to be pinpointed to individual systems or components. Test lane control charts shall include at a minimum:

(i) Overall number of voided tests

(ii) Number of voided tests by type

(iii) Level of difference between theoretical and measured coast-down times

(iv) Level of difference between theoretical and measured CVS flow

(v) Level of up-scale span change from last up-scale span (not required if software corrections are tracked)

(vi) Level of mathematical or software correction to the calibration curve as a result of an up-scale span change (if used)

(vii) Level of difference between the analyzer response to the daily cross-check, and the test gas concentration

(viii) Level of difference between the integrated measurements and the bag measurements

(ix) The system response time

(x) Level of the FID CH_4 response ratio

(xi) Level of the ambient background concentrations

(xii) The average, median, 10^{th} percentile and 90^{th} percentile of the composite emissions (HC, CO, CO_2, and NOx) measured over the defined periodic basis

(xiii) Average number of passing vehicles, and average number of failing vehicles over the defined periodic basis

(xiv) Level of difference between theoretical or measured values for other parameters measured during quality assurance procedures

(3) Control Charts for Individual Facilities. Control charts for individual facilities shall consist of facility-averages of the test lane control charts for each test lane at the facility.

(4) Combined Control Charts for All Facilities. Combined control charts for all of the facilities in a given network shall consist of an average of the facility-average control charts for each facility.

(5) Control Charts of Individual Inspectors. Control charts for individual inspectors shall include parameters that will allow the cause for abnormal performance to be evaluated. Control charts for individual inspectors shall be compared to the combined control charts for each facility and for the network.

§85.2235 Evaporative Test System Quality Control Requirements

(a) Evaporative Purge Analysis System Flow Checks

(1) Daily Check. Each flow meter used to measure purge flow shall be checked each operating day with simulated purge flow (e.g., auxiliary pneumatic pump) against a reference flow measuring device with performance specifications equal to or better than those specified for the purge meter. The check shall be made at a flow rate of between 4 and 5 liters per minute. The test shall be conducted for one minute. Deviations greater than ±0.3 liters per minute, or ±3% of total flow from the values determined by the reference device shall require corrective action.

(2) Monthly Check. On a monthly basis, the calibration of purge meters shall be checked for total volume of flow at 0.8, 2, 20, and 35 liters over 4 minutes with a device or method capable of measuring these flow volumes to within ±0.2 liters over the test period. Deviations exceeding 1.5 times the specifications in §85.2227(b)(2)(v)(D) shall require corrective action.

(3) Alternative Frequencies. Where appropriate, control charts and statistical process control (SPC) theory shall be used to determine, forecast, and maintain performance of the purge measurement system.

(b) Evaporative System Integrity Checks

(1) Daily Checks. Relevant parameters of the evaporative system integrity analysis system shall be checked on each operating day.

(i) Systems that monitor pressure decay shall be checked for integrity. If, after the vehicle attachment end of the checking system is capped and the checking system is pressurized to between 14 and 28 inches of water, the pressure system changes more than 0.2 inches of water over 15 seconds, testing shall be automatically prevented until corrective action is taken.

(ii) The gas cap flow tester shall be verified daily by testing and correctly identifying the passing and failing reference fuel caps. The tester shall be automatically locked out from use until it properly fails and passes the reference caps. Flow calibration of the reference fuel caps shall be conducted before initial usage and thereafter as required by examining quality control data.

(2) Weekly Check. Pressure gauges or measurement devices shall be checked on a weekly basis against a reference gauge or device equal to or better than the specified performance requirements. Deviations exceeding the specified accuracy shall require corrective action.

(3) Annual Check. The flow standard orifice shall be calibrated before initial usage and thereafter on an annual basis unless quality control data suggests other intervals are appropriate. The flow calibration method shall be traceable to NIST.

(4) Filter Check. The gas cap flow tester filter shall be maintained in accordance with the leak test manufacturer's recommendations.

(5) Alternative Frequencies. Where appropriate, control charts and statistical process control (SPC) theory shall be used to determine, forecast, and maintain performance of the overall pressure and flow test measurement systems.

§85.2239 Test Report

(a) General Test Report Information

(1) Vehicle Description.

(i) License plate number,
(ii) Vehicle identification number,
(iii) Weight class, and
(iv) Odometer reading.

(2) Date and end time of the tailpipe emission measurement test.

(3) Name or identification number of the individual performing the test and the location of the test station and lane.

(4) For failed vehicles, a statement indicating the availability of warranty coverage as provided in Section 207 of the Clean Air Act.

(5) A statement certifying that the short tests were performed in accordance with applicable regulations.

(b) Tests and Results

(1) Test Types and Standards. The test report shall indicate the types of tests performed on the vehicle and the test standards for each. Test standards shall be displayed to the appropriate number of significant digits as in §85.2205(a). For the IM240 the reported standards shall be the composite test standards.

(2) Test Scores. The test report shall show the scores for each test performed. Test scores shall be displayed to the same number of significant digits as the standards.

(3) IM240 Scores. The reported score for the IM240 shall be in units of grams per mile and shall be selected based upon the following:

(i) If the emissions of any exhaust component on the composite IM240 are below the applicable standard in §85.2205(a), then the vehicle shall pass for that constituent and the composite score shall be reported.

(ii) If the emissions of any exhaust component on the composite IM240 exceed the applicable standard in §85.2205(a) but are below the Phase 2 standard, then the vehicle shall pass for that component and the Phase 2 score shall be reported.

(iii) If the emissions of any exhaust component on the composite IM240 exceed the applicable standard in §85.2205(a)(2) through §85.2205(a)(4) and exceed the Two Ways to Pass Standard as described in §85.2205(a)(1), then the vehicle shall fail for that component and the composite score shall be reported.

(iv) If a passing decision is made for all three exhaust components on the IM240, and for purge before the end of the full driving cycle according to the criteria described in §85.2205(a)(4) and §85.2205(c)(2), the passing results and reported emissions levels shall be those obtained at the time the test is terminated. Emission levels for the IM240 shall be reported in grams per mile calculated using the full IM240 mileage (not actual mileage). The emission standards reported shall be the composite standards (i.e., not the fast-pass standards).

(4) Purge Scores. The score for the purge test shall be reported in units of liters and shall be selected based upon the following:

(i) If purge levels at the conclusion of the transient driving cycle are below the applicable standard in §85.2205(c)(1), then the vehicle shall fail.

(ii) If a passing decision is made for all three exhaust components on the IM240, and for purge before the end of the full driving cycle according to the criteria described in §85.2205(a)(4) and §85.2205(c)(3), the passing result and reported cumulative purge levels shall be those obtained at the time the test is terminated.

(5) Pressure Test Scores. The score(s) for the pressure test(s) shall be reported as a change in pressure expressed in inches of water.

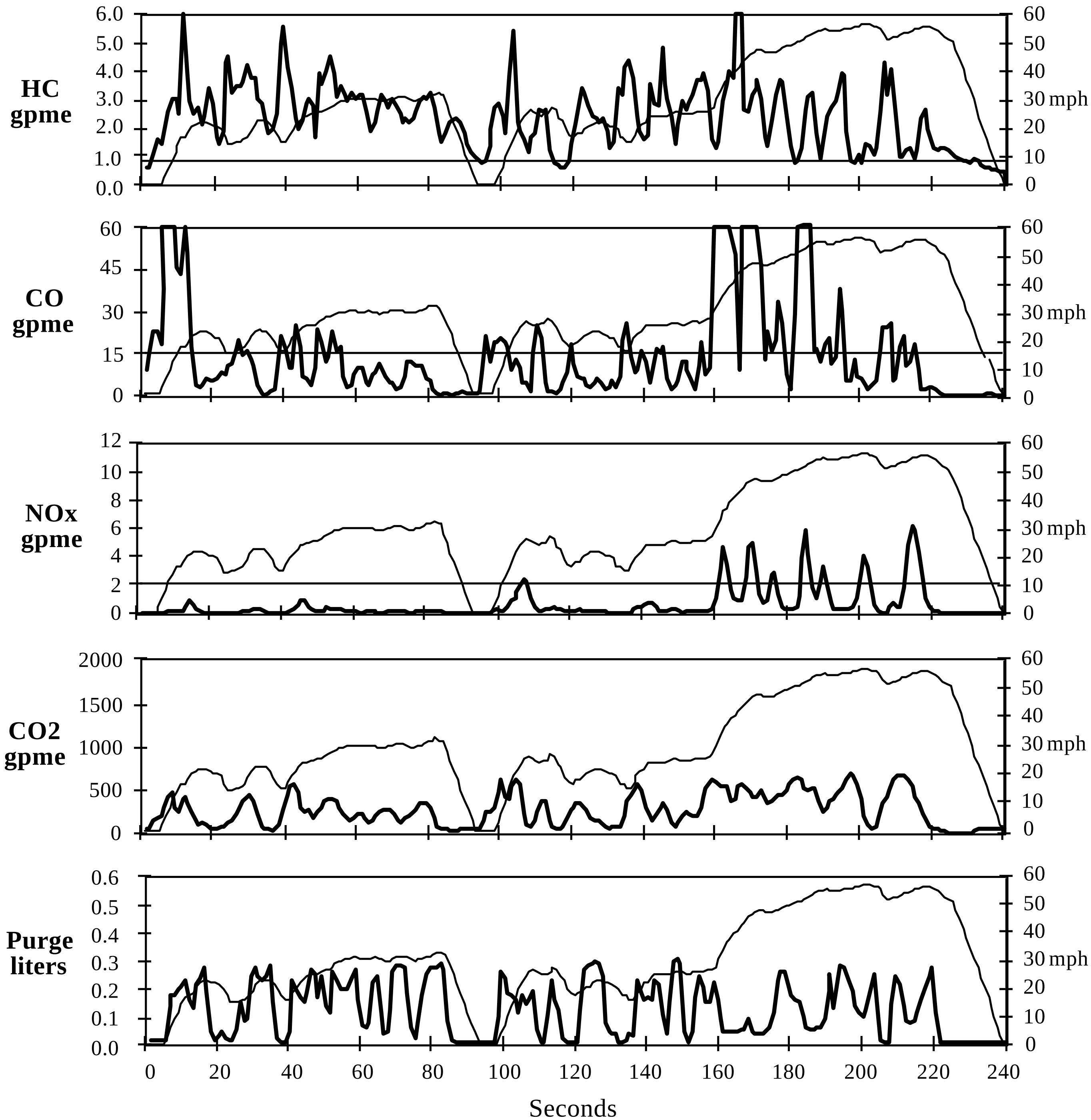
(6) Test Results. The test report shall indicate the pass/fail result for each test performed and the overall result. In the case of exhaust emission tests, the report shall indicate the pass/fail status for each component for which standards apply.

(7) Second-by-Second Measurements. For vehicles failing the IM240, a graph showing the second-by-second emission levels (see following example), for each exhaust component in grams per mile equivalent, and for purge in liters per second shall be given to the motorist.

Recommended IM240 Second-By-Second Emissions Report

Test Number 4719

Model Year	1988	Test Weight	3000	Emission	Actual	Cutpoint
Make	XXXX	TRLHP	14.7	HC (gpm)	2.45	0.80
Model	YYYY	Traction Control	No	CO (gpm)	23.1	15.0
Cylinders	4	ABS	No	NOx (gpm)	0.71	2.00
Transmission	Auto	Purge Test	Yes	CO2 (gpm)	279	n/a
Vehicle Type	LDGV	Press Test	Yes	Purge (L)	30.2	1.0


6.0
5.0
4.0
3.0
2.0
1.0
0.0
HC gpme
60
50
40
30 mph
20
10
0
60
45
30
15
0
CO gpme
NOx gpme
12
10
8
6
4
2
CO2 gpme
2000
1500
1000
500
Purge liters
0.6
0.5
0.4
0.3
0.2
0.1
0 20 40 60 80 100 120 140 160 180 200 220 240
Seconds

§85.2231 Terms

(a) Definitions

(1) Track coast-down target time: The new vehicle certification track coast-down time between 55 and 45 mph.

(2) Road load horsepower: The power required for a vehicle to maintain a given constant speed taking into account power losses due to such things as wind resistance, tire losses, bearing friction, etc.

(3) Tier 1: New gaseous and particulate tailpipe emission standards for use in certifying new light duty vehicles and light duty trucks phased in beginning with the 1994 model year.

(4) CVS hose: The hose, connecting to the tailpipe of the vehicle, that carries exhaust and dilution air to the stationary portion of the CVS system.

(b) Abbreviations

(1)	CFV:	Critical flow venturi
(2)	CH_4:	Methane
(3)	CO_2:	Carbon dioxide
(4)	CO:	Carbon monoxide
(5)	CRM:	Certified reference material
(6)	CVS:	constant volume sampler
(7)	FID:	Flame ionization detector
(8)	gpm:	Grams per mile
(9)	GVWR:	Gross Vehicle Weight Rating
(10)	HC:	Hydrocarbons
(11)	HDGT:	Heavy-Duty Gasoline-powered Truck greater than 8500 pounds GVWR
(12)	hp:	horsepower
(13)	Hz:	cycles per second (Hertz)
(14)	I/M:	Inspection and Maintenance
(15)	IW:	Inertia weight
(16)	LDGT1:	Light-Duty Gasoline-powered Truck from 0 to 6000 pounds GVWR
(17)	LDGT2:	Light-Duty Gasoline-powered Truck from 6001 to 8500 pounds GVWR
(18)	LDGV:	Light-Duty Gasoline-powered Vehicle
(19)	LVW	Loaded Vehicle Weight
(20)	mph:	Miles per hour
(21)	NDIR:	non-dispersive infrared
(22)	NIST:	National Institute for Standards and Technology
(23)	NO_2:	Nitrogen dioxide
(24)	NO:	Nitrogen oxide
(25)	NOx:	Oxides of nitrogen
(26)	NVFEL:	National Vehicle and Fuel Emissions Laboratory
(27)	Obmph:	Observed dynamometer speed in mph of the loading roller, if rolls are not coupled
(28)	PLHP:	Parasitic horsepower loss at the observed dynamometer speed in mph
(29)	ppm:	parts per million by volume
(30)	ppmC:	parts per million, carbon

(31) psi: Pounds per square inch
(32) RFP: Request for Proposal
(33) RLHP Road Load Horsepower
(34) rpm: revolutions per minute
(35) SCFM: standard cubic feet per minute
(36) SPC: Statistical process control
(37) SRM: Standard reference material
(38) SSV: Subsonic venturi
(39) TRLHP: Track road-load horsepower

Appendix A

Guidance on the Use of Fast-Pass IM240 Standards

Guidance on the Use of Fast-Pass IM240 Standards

A fast-pass decision is made by measuring the vehicle's cumulative emissions of each pollutant in each second, and comparing them to cumulative emission fast-pass standards for each pollutant for the second of the test under consideration. In general, if the vehicle's cumulative emissions are below a given level for all pollutants the vehicle passes. Testing continues until decisions are made for each pollutant and for purge. Measurements of all constituents shall continue to be taken as long as the test continues, including those constituents for which a decision has already been made.

These fast-pass standards are derived from an Arizona IM240 data set which included 3,718 tests. Fast-pass standards for each second represent the tenth lowest cumulative emission levels in that second obtained for vehicles failing the IM240 using the two-ways-to-pass criteria. Hence, vehicles that fall below this level are showing lower cumulative emissions at that point in the test than the cleanest vehicles failing the full test and therefore pass. Fast-pass determinations begin at second 30 of the IM240 cycle.

Beginning at second 104, fast pass decisions for HC and CO are based upon analysis of cumulative emissions in phase 2, the portion of the test beginning at second 94, as well as emission levels accumulated from the beginning of the test (the "composite" test). Fast-pass standards are derived for phase 2 of the test as described above. Since the phase 2 standards for NOx are the same as the composite, the phase 2 NOx fast-pass standards are also the same as the composite.

The fast-pass algorithm for purge is essentially the same as for tailpipe emissions. Second-by-second cumulative purge levels are compared with second-by-second cumulative purge pass standards. Fast-pass standards correspond to the tenth highest cumulative purge levels for failing vehicles. There are no Phase 2 standards for purge.

A vehicle passes the IM240/purge test if cumulative composite purge is above the cumulative composite purge fast-pass standard, and if any of the following three conditions occur:

- cumulative composite emissions of HC, CO, and NOx are below the composite fast-pass standards;
- cumulative phase 2 emissions of HC, CO, and NOx are below the phase 2 fast-pass standards;
- any combination of the first two conditions exist.

Scores

HC_t = cumulative composite HC at time = *t* seconds
CO_t = cumulative composite CO at time = *t* seconds
NOx_t = cumulative composite NOx at time = *t* seconds
P_t = cumulative composite purge at time = *t* seconds

HC_{bt} = cumulative Phase 2 HC at time = *t* seconds
CO_{bt} = cumulative Phase 2 CO at time = *t* seconds
NOx_{bt} = cumulative Phase 2 NOx at time = *t* seconds

Cumulative composite scores represent the cumulative grams of emissions from $t = 0$ seconds
Cumulative Phase 2 scores represent the cumulative grams of emissions from $t = 104$ seconds

Fast-Pass Standards

HC_{pt} = composite HC fast-pass standard at time = t seconds
CO_{pt} = composite CO fast-pass standard at time = t seconds
NOx_{pt} = composite NOx fast-pass standard for failing vehicles at time = t seconds
P_{pt} = composite purge fast-pass standard at time = t seconds

HC_{pbt} = Phase 2 HC fast-pass standard at time = t seconds
CO_{pbt} = Phase 2 CO fast-pass standard at time = t seconds
NOx_{pbt} = Phase 2 NOx fast-pass standard at time = t seconds

Fast-Pass Conditions

For $t > 30$ seconds, the vehicle shall pass if:
$HC_t < HC_{pt}$ and $CO_t < CO_{pt}$, $NOx_t < NOx_{pt}$; and $P_t > P_{pt}$
additionally, for $t > 104$ seconds, the vehicle shall pass if:
$HC_{bt} < HC_{pbt}$ and $CO_{bt} < CO_{pbt}$ and $NOx_{bt} < NOx_{pbt}$ and $P_t > P_{pt}$, or
$HC_t < HC_{pt}$ and $CO_{bt} < CO_{pbt}$ and $NOx_{bt} < NOx_{pbt}$ and $P_t > P_{pt}$, or
$HC_t < HC_{pt}$ and $CO_t < CO_{pt}$ and $NOx_{bt} < NOx_{pbt}$ and $P_t > P_{pt}$, or
$HC_{bt} < HC_{pbt}$ and $CO_t < CO_{pt}$ and $NOx_{bt} < NOx_{pbt}$ and $P_t > P_{pt}$, or
$HC_{bt} < HC_{pbt}$ and $CO_t < CO_{pt}$ and $NOx_t < NOx_{pt}$ and $P_t > P_{pt}$, or
$HC_{bt} < HC_{pbt}$ and $CO_{bt} < CO_{pbt}$ and $NOx_t < NOx_{pt}$ and $P_t > P_{pt}$,

IM240 FAST-PASS EMISSION STANDARDS

(grams)

	Hydrocarbons						Carbon Monoxide						Oxides of Nitrogen			
Sec IM240	**Composite 0.8**	**Phase 2 0.5**	**Composite 1.25**	**Phase 2 0.75**	**Composite 2.00**	**Phase 2 1.25**	**Composite 15.0**	**Phase 2 12.0**	**Composite 20.0**	**Phase 2 16.0**	**Composite 30.0**	**Phase 2 24.0**	**2.0**	**2.5**	**3.0**	**Evap System Purge**
30	0.124	n/a	0.247	n/a	0.407	n/a	0.693	n/a	1.502	n/a	3.804	n/a	0.167	0.262	0.419	0.14
31	0.126	n/a	0.253	n/a	0.415	n/a	0.773	n/a	1.546	n/a	3.985	n/a	0.177	0.275	0.425	0.14
32	0.129	n/a	0.258	n/a	0.423	n/a	0.837	n/a	1.568	n/a	4.215	n/a	0.188	0.301	0.431	0.15
33	0.135	n/a	0.263	n/a	0.436	n/a	0.851	n/a	1.582	n/a	4.440	n/a	0.214	0.317	0.449	0.15
34	0.140	n/a	0.268	n/a	0.451	n/a	0.853	n/a	1.593	n/a	4.579	n/a	0.232	0.327	0.476	0.16
35	0.146	n/a	0.277	n/a	0.464	n/a	0.857	n/a	1.602	n/a	4.688	n/a	0.240	0.330	0.497	0.16
36	0.150	n/a	0.283	n/a	0.468	n/a	0.900	n/a	1.621	n/a	4.749	n/a	0.243	0.332	0.515	0.16
37	0.153	n/a	0.293	n/a	0.475	n/a	0.960	n/a	1.631	n/a	4.783	n/a	0.245	0.334	0.516	0.17
38	0.156	n/a	0.297	n/a	0.487	n/a	1.034	n/a	1.702	n/a	4.813	n/a	0.246	0.336	0.519	0.18
39	0.160	n/a	0.298	n/a	0.506	n/a	1.070	n/a	1.784	n/a	4.876	n/a	0.246	0.337	0.527	0.18
40	0.165	n/a	0.313	n/a	0.530	n/a	1.076	n/a	1.879	n/a	5.104	n/a	0.250	0.354	0.542	0.19
41	0.169	n/a	0.320	n/a	0.549	n/a	1.083	n/a	2.162	n/a	5.217	n/a	0.260	0.366	0.560	0.19
42	0.172	n/a	0.327	n/a	0.569	n/a	1.102	n/a	2.307	n/a	5.383	n/a	0.277	0.410	0.598	0.19
43	0.173	n/a	0.342	n/a	0.588	n/a	1.111	n/a	2.343	n/a	5.571	n/a	0.311	0.414	0.616	0.20
44	0.177	n/a	0.360	n/a	0.609	n/a	1.114	n/a	2.376	n/a	5.888	n/a	0.328	0.438	0.645	0.20
45	0.197	n/a	0.376	n/a	0.621	n/a	1.157	n/a	2.406	n/a	6.199	n/a	0.343	0.477	0.670	0.20
46	0.200	n/a	0.389	n/a	0.636	n/a	1.344	n/a	2.433	n/a	6.245	n/a	0.359	0.506	0.691	0.21
47	0.208	n/a	0.408	n/a	0.649	n/a	1.482	n/a	2.458	n/a	6.318	n/a	0.373	0.518	0.716	0.22
48	0.221	n/a	0.423	n/a	0.666	n/a	1.530	n/a	2.483	n/a	6.418	n/a	0.383	0.522	0.735	0.22
49	0.232	n/a	0.434	n/a	0.679	n/a	1.542	n/a	2.774	n/a	6.540	n/a	0.385	0.526	0.765	0.22
50	0.235	n/a	0.444	n/a	0.696	n/a	1.553	n/a	2.844	n/a	6.690	n/a	0.400	0.554	0.802	0.23
51	0.238	n/a	0.454	n/a	0.712	n/a	1.571	n/a	2.900	n/a	6.875	n/a	0.410	0.574	0.836	0.24
52	0.240	n/a	0.465	n/a	0.727	n/a	1.595	n/a	2.936	n/a	7.029	n/a	0.434	0.587	0.868	0.24
53	0.242	n/a	0.472	n/a	0.745	n/a	1.633	n/a	3.133	n/a	7.129	n/a	0.464	0.601	0.890	0.24
54	0.246	n/a	0.478	n/a	0.760	n/a	1.685	n/a	3.304	n/a	7.359	n/a	0.472	0.615	0.918	0.24
55	0.249	n/a	0.485	n/a	0.776	n/a	1.689	n/a	3.407	n/a	7.722	n/a	0.480	0.629	0.936	0.24
56	0.252	n/a	0.493	n/a	0.797	n/a	1.693	n/a	3.456	n/a	8.017	n/a	0.491	0.643	0.947	0.24
57	0.261	n/a	0.500	n/a	0.814	n/a	1.700	n/a	3.480	n/a	8.249	n/a	0.500	0.667	0.958	0.24
58	0.271	n/a	0.505	n/a	0.826	n/a	1.723	n/a	3.518	n/a	8.425	n/a	0.506	0.678	0.970	0.25
59	0.276	n/a	0.514	n/a	0.837	n/a	1.852	n/a	3.560	n/a	8.563	n/a	0.509	0.683	0.982	0.25
60	0.278	n/a	0.537	n/a	0.849	n/a	1.872	n/a	3.593	n/a	8.686	n/a	0.512	0.686	0.994	0.25
61	0.280	n/a	0.540	n/a	0.862	n/a	1.872	n/a	3.628	n/a	8.804	n/a	0.516	0.693	1.019	0.26
62	0.282	n/a	0.543	n/a	0.872	n/a	1.872	n/a	3.641	n/a	8.916	n/a	0.519	0.699	1.042	0.26
63	0.283	n/a	0.546	n/a	0.887	n/a	1.900	n/a	3.655	n/a	9.025	n/a	0.523	0.703	1.049	0.26
64	0.284	n/a	0.551	n/a	0.895	n/a	1.917	n/a	3.680	n/a	9.138	n/a	0.529	0.707	1.058	0.27
65	0.285	n/a	0.559	n/a	0.903	n/a	1.944	n/a	3.700	n/a	9.250	n/a	0.533	0.711	1.062	0.27
66	0.286	n/a	0.567	n/a	0.925	n/a	2.000	n/a	3.728	n/a	9.354	n/a	0.535	0.716	1.064	0.27
67	0.288	n/a	0.575	n/a	0.933	n/a	2.060	n/a	3.857	n/a	9.457	n/a	0.540	0.721	1.070	0.28
68	0.291	n/a	0.588	n/a	0.945	n/a	2.064	n/a	3.894	n/a	9.575	n/a	0.551	0.726	1.077	0.28
69	0.294	n/a	0.595	n/a	0.959	n/a	2.076	n/a	3.943	n/a	9.728	n/a	0.563	0.742	1.085	0.29
70	0.296	n/a	0.601	n/a	0.970	n/a	2.104	n/a	3.983	n/a	9.938	n/a	0.575	0.759	1.092	0.29
71	0.298	n/a	0.606	n/a	0.980	n/a	2.117	n/a	4.009	n/a	10.140	n/a	0.588	0.773	1.101	0.29
72	0.300	n/a	0.610	n/a	0.988	n/a	2.125	n/a	4.023	n/a	10.222	n/a	0.600	0.784	1.111	0.29
73	0.302	n/a	0.617	n/a	0.997	n/a	2.130	n/a	4.023	n/a	10.261	n/a	0.603	0.790	1.121	0.30
74	0.304	n/a	0.631	n/a	1.022	n/a	2.138	n/a	4.053	n/a	10.278	n/a	0.604	0.794	1.131	0.30
75	0.307	n/a	0.643	n/a	1.037	n/a	2.152	n/a	4.063	n/a	10.290	n/a	0.613	0.799	1.141	0.30
76	0.308	n/a	0.651	n/a	1.051	n/a	2.170	n/a	4.077	n/a	10.715	n/a	0.624	0.809	1.159	0.31
77	0.308	n/a	0.659	n/a	1.064	n/a	2.188	n/a	4.225	n/a	10.790	n/a	0.646	0.821	1.164	0.31
78	0.308	n/a	0.667	n/a	1.075	n/a	2.200	n/a	4.243	n/a	10.844	n/a	0.651	0.833	1.186	0.32
79	0.314	n/a	0.676	n/a	1.087	n/a	2.212	n/a	4.260	n/a	10.921	n/a	0.659	0.839	1.221	0.32
80	0.320	n/a	0.681	n/a	1.097	n/a	2.212	n/a	4.282	n/a	11.010	n/a	0.673	0.844	1.260	0.32
81	0.324	n/a	0.685	n/a	1.105	n/a	2.221	n/a	4.322	n/a	11.090	n/a	0.696	0.857	1.268	0.32
82	0.327	n/a	0.689	n/a	1.114	n/a	2.222	n/a	4.398	n/a	11.136	n/a	0.706	0.870	1.272	0.33
83	0.329	n/a	0.694	n/a	1.136	n/a	2.227	n/a	4.482	n/a	11.136	n/a	0.715	0.883	1.277	0.33
84	0.333	n/a	0.700	n/a	1.160	n/a	2.236	n/a	4.515	n/a	11.165	n/a	0.724	0.894	1.288	0.34
85	0.336	n/a	0.705	n/a	1.182	n/a	2.243	n/a	4.518	n/a	11.191	n/a	0.737	0.902	1.310	0.34
86	0.339	n/a	0.709	n/a	1.201	n/a	2.262	n/a	4.520	n/a	11.205	n/a	0.747	0.907	1.319	0.34
87	0.343	n/a	0.713	n/a	1.217	n/a	2.271	n/a	4.522	n/a	11.211	n/a	0.748	0.910	1.320	0.35
88	0.347	n/a	0.717	n/a	1.233	n/a	2.284	n/a	4.522	n/a	11.211	n/a	0.748	0.912	1.337	0.35
89	0.350	n/a	0.721	n/a	1.248	n/a	2.299	n/a	4.523	n/a	11.211	n/a	0.748	0.913	1.348	0.35
90	0.356	n/a	0.724	n/a	1.262	n/a	2.308	n/a	4.526	n/a	11.211	n/a	0.748	0.914	1.361	0.36
91	0.358	n/a	0.727	n/a	1.271	n/a	2.326	n/a	4.527	n/a	11.220	n/a	0.748	0.915	1.366	0.36
92	0.360	n/a	0.729	n/a	1.279	n/a	2.330	n/a	4.527	n/a	11.294	n/a	0.748	0.916	1.369	0.37
93	0.363	n/a	0.731	n/a	1.287	n/a	2.331	n/a	4.528	n/a	11.332	n/a	0.748	0.917	1.373	0.37
94	0.367	n/a	0.734	n/a	1.295	n/a	2.344	n/a	4.528	n/a	11.355	n/a	0.748	0.918	1.375	0.37
95	0.370	n/a	0.740	n/a	1.302	n/a	2.347	n/a	4.528	n/a	11.383	n/a	0.748	0.919	1.377	0.38
96	0.372	n/a	0.748	n/a	1.309	n/a	2.355	n/a	4.529	n/a	11.410	n/a	0.748	0.920	1.379	0.38
97	0.376	n/a	0.759	n/a	1.316	n/a	2.395	n/a	4.575	n/a	11.433	n/a	0.748	0.921	1.381	0.39
98	0.388	n/a	0.771	n/a	1.325	n/a	2.451	n/a	4.703	n/a	11.516	n/a	0.748	0.922	1.383	0.39
99	0.396	n/a	0.783	n/a	1.339	n/a	2.508	n/a	4.805	n/a	11.820	n/a	0.751	0.924	1.385	0.39
100	0.405	n/a	0.793	n/a	1.356	n/a	2.590	n/a	4.886	n/a	12.104	n/a	0.764	0.929	1.399	0.40
101	0.410	n/a	0.810	n/a	1.365	n/a	2.660	n/a	4.957	n/a	12.344	n/a	0.789	0.941	1.405	0.40
102	0.411	n/a	0.823	n/a	1.378	n/a	2.749	n/a	5.104	n/a	12.781	n/a	0.822	0.970	1.466	0.40
103	0.412	n/a	0.836	n/a	1.397	n/a	2.913	n/a	5.340	n/a	13.472	n/a	0.867	1.027	1.485	0.41

104	0.413	0.007	0.853	0.016	1.420	0.055	3.162	0.038	5.496	0.094	14.405	0.582	0.905	1.093	1.546	0.41
105	0.421	0.008	0.871	0.017	1.445	0.094	3.170	0.039	5.625	0.122	14.808	0.800	0.925	1.155	1.623	0.41
106	0.428	0.009	0.887	0.022	1.470	0.110	3.197	0.061	5.815	0.151	14.965	0.925	0.955	1.234	1.699	0.42
107	0.430	0.010	0.899	0.029	1.491	0.116	3.288	0.062	6.473	0.191	15.121	0.973	0.985	1.275	1.760	0.42
108	0.455	0.013	0.931	0.036	1.506	0.132	3.419	0.108	7.037	0.234	15.372	1.091	0.993	1.305	1.788	0.43
109	0.459	0.015	0.947	0.040	1.517	0.151	3.587	0.168	7.419	0.246	15.530	1.113	0.995	1.320	1.798	0.43
110	0.462	0.017	0.957	0.047	1.528	0.159	3.595	0.173	7.643	0.257	15.687	1.213	0.996	1.332	1.842	0.43
111	0.464	0.021	0.965	0.052	1.542	0.172	3.640	0.237	7.759	0.286	16.018	1.344	1.010	1.346	1.864	0.44
112	0.466	0.024	0.971	0.056	1.559	0.186	3.740	0.266	7.824	0.379	16.527	1.399	1.028	1.358	1.888	0.44
113	0.468	0.024	0.977	0.061	1.578	0.199	3.868	0.280	7.889	0.425	16.810	1.520	1.034	1.378	1.905	0.44
114	0.471	0.025	0.983	0.064	1.594	0.207	3.877	0.291	7.960	0.457	16.961	1.640	1.044	1.406	1.920	0.44
115	0.488	0.026	1.003	0.072	1.605	0.216	3.934	0.314	8.024	0.477	17.120	1.684	1.059	1.426	1.926	0.45
116	0.513	0.029	1.030	0.081	1.615	0.229	4.015	0.331	8.076	0.494	17.135	1.693	1.075	1.438	1.939	0.46
117	0.538	0.032	1.041	0.082	1.625	0.235	4.061	0.345	8.111	0.504	17.249	1.786	1.080	1.448	1.958	0.46
118	0.561	0.035	1.050	0.083	1.642	0.240	4.063	0.350	8.130	0.512	17.451	2.007	1.080	1.460	1.972	0.47
119	0.577	0.035	1.052	0.092	1.670	0.245	4.079	0.356	8.148	0.519	17.509	2.084	1.081	1.462	1.981	0.47
120	0.580	0.036	1.055	0.094	1.694	0.261	4.140	0.367	8.211	0.529	17.605	2.179	1.091	1.467	1.987	0.47
121	0.586	0.038	1.061	0.097	1.705	0.267	4.185	0.388	8.478	0.529	17.734	2.264	1.096	1.476	1.991	0.48
122	0.594	0.040	1.071	0.100	1.717	0.277	4.199	0.407	8.548	0.530	18.049	2.328	1.111	1.494	1.996	0.48
123	0.603	0.041	1.081	0.103	1.732	0.287	4.205	0.463	8.561	0.531	18.447	2.375	1.122	1.505	2.012	0.48
124	0.610	0.042	1.091	0.106	1.747	0.298	4.212	0.480	8.568	0.532	18.592	2.437	1.135	1.517	2.040	0.49
125	0.615	0.042	1.102	0.108	1.763	0.308	4.232	0.506	8.572	0.533	18.657	2.543	1.138	1.546	2.060	0.49
126	0.624	0.042	1.110	0.110	1.779	0.316	4.298	0.518	8.584	0.548	18.796	2.593	1.139	1.569	2.069	0.50
127	0.628	0.045	1.116	0.112	1.795	0.322	4.344	0.522	8.592	0.610	18.952	2.641	1.139	1.586	2.092	0.50
128	0.632	0.046	1.121	0.114	1.810	0.329	4.361	0.525	8.596	0.614	19.137	2.663	1.139	1.596	2.114	0.50
129	0.637	0.046	1.125	0.116	1.823	0.338	4.366	0.528	8.597	0.622	19.329	2.672	1.139	1.603	2.132	0.50
130	0.641	0.049	1.128	0.118	1.835	0.346	4.369	0.530	8.601	0.631	19.519	2.676	1.139	1.605	2.144	0.51
131	0.643	0.050	1.130	0.120	1.845	0.354	4.372	0.530	8.605	0.640	19.707	2.683	1.139	1.606	2.152	0.52
132	0.644	0.052	1.132	0.122	1.854	0.356	4.435	0.534	8.608	0.646	19.882	2.817	1.139	1.607	2.157	0.52
133	0.645	0.054	1.134	0.123	1.862	0.357	4.523	0.550	8.626	0.650	19.905	2.992	1.139	1.607	2.160	0.52
134	0.647	0.054	1.135	0.124	1.870	0.359	4.524	0.554	8.650	0.652	20.049	3.111	1.139	1.608	2.163	0.53
135	0.651	0.054	1.143	0.127	1.883	0.362	4.525	0.590	8.660	0.738	20.460	3.234	1.139	1.614	2.165	0.53
136	0.658	0.055	1.147	0.130	1.888	0.364	4.531	0.616	8.767	0.754	20.746	3.304	1.160	1.616	2.168	0.54
137	0.663	0.055	1.156	0.134	1.896	0.368	4.534	0.639	9.029	0.780	21.068	3.310	1.174	1.631	2.171	0.54
138	0.666	0.056	1.163	0.139	1.911	0.378	4.542	0.653	9.238	0.795	21.380	3.320	1.183	1.643	2.186	0.54
139	0.668	0.059	1.186	0.146	1.928	0.391	4.553	0.662	9.389	0.804	21.748	3.354	1.197	1.656	2.235	0.55
140	0.670	0.061	1.253	0.149	1.949	0.402	4.554	0.683	9.493	0.810	22.046	3.436	1.223	1.673	2.298	0.55
141	0.672	0.061	1.262	0.151	1.969	0.408	4.554	0.696	9.583	0.815	22.348	3.443	1.255	1.703	2.333	0.56
142	0.675	0.061	1.271	0.153	1.982	0.422	4.554	0.708	9.626	0.818	22.397	3.452	1.272	1.739	2.373	0.56
143	0.678	0.063	1.277	0.155	1.999	0.428	4.554	0.721	9.669	0.821	22.407	3.490	1.286	1.767	2.406	0.56
144	0.681	0.064	1.283	0.157	2.011	0.432	4.554	0.739	9.716	0.825	22.417	3.552	1.304	1.774	2.416	0.56
145	0.684	0.065	1.291	0.162	2.022	0.434	4.554	0.742	9.763	0.840	22.922	3.588	1.307	1.785	2.420	0.57
146	0.686	0.066	1.294	0.164	2.035	0.439	4.554	0.743	9.809	0.847	22.951	3.600	1.312	1.806	2.424	0.57
147	0.688	0.067	1.296	0.166	2.043	0.450	4.554	0.745	9.852	0.855	22.976	3.616	1.317	1.830	2.435	0.58
148	0.690	0.068	1.298	0.168	2.049	0.460	4.554	0.748	9.885	0.865	23.017	3.627	1.321	1.844	2.455	0.58
149	0.692	0.069	1.303	0.169	2.063	0.467	4.554	0.751	9.932	0.874	23.073	3.636	1.325	1.845	2.471	0.59
150	0.694	0.070	1.316	0.170	2.085	0.472	4.554	0.762	9.986	0.891	23.161	3.676	1.328	1.846	2.484	0.59
151	0.696	0.071	1.330	0.171	2.104	0.480	4.556	0.789	10.039	0.914	23.218	3.882	1.332	1.852	2.495	0.59
152	0.698	0.072	1.342	0.172	2.117	0.491	4.556	0.790	10.072	0.929	23.253	4.011	1.338	1.868	2.509	0.59
153	0.700	0.073	1.348	0.173	2.127	0.503	4.565	0.794	10.090	0.937	23.337	4.047	1.344	1.877	2.522	0.59
154	0.702	0.073	1.353	0.175	2.138	0.505	4.612	0.799	10.105	0.942	23.425	4.067	1.350	1.879	2.533	0.59
155	0.704	0.074	1.362	0.178	2.152	0.515	4.834	0.805	10.146	0.949	23.534	4.081	1.357	1.886	2.541	0.60
156	0.706	0.077	1.365	0.180	2.168	0.522	5.702	0.842	10.245	1.375	23.652	4.116	1.365	1.900	2.552	0.60
157	0.708	0.079	1.366	0.189	2.186	0.527	5.841	0.990	10.397	1.576	23.739	4.251	1.379	1.910	2.589	0.61
158	0.710	0.082	1.373	0.198	2.205	0.537	6.170	1.038	10.923	1.943	24.606	5.099	1.414	1.936	2.631	0.61
159	0.712	0.082	1.397	0.203	2.224	0.549	6.670	1.357	11.970	2.820	25.615	5.383	1.466	1.954	2.704	0.61
160	0.716	0.086	1.423	0.207	2.242	0.568	7.425	1.455	13.421	3.281	26.073	6.362	1.514	1.986	2.758	0.61
161	0.750	0.095	1.440	0.214	2.268	0.586	8.379	1.546	15.289	3.483	28.496	7.926	1.559	2.050	2.802	0.62
162	0.784	0.107	1.452	0.221	2.308	0.610	9.648	1.824	15.912	3.620	29.772	8.429	1.591	2.131	2.904	0.62
163	0.805	0.115	1.465	0.229	2.352	0.648	10.918	2.746	16.530	4.168	31.056	9.201	1.641	2.235	2.960	0.63
164	0.840	0.122	1.509	0.247	2.406	0.677	12.157	3.073	17.622	4.338	33.351	10.825	1.719	2.320	3.027	0.63
165	0.853	0.127	1.533	0.274	2.421	0.699	12.731	3.633	18.366	4.682	34.890	12.291	1.777	2.395	3.127	0.64
166	0.874	0.159	1.555	0.309	2.435	0.720	12.831	4.505	19.869	5.633	35.937	13.366	1.832	2.488	3.187	0.64
167	0.903	0.186	1.576	0.318	2.470	0.738	12.892	4.952	20.711	6.137	37.012	14.428	1.919	2.563	3.306	0.64
168	0.910	0.189	1.598	0.322	2.501	0.767	12.932	5.254	22.319	6.853	37.892	15.318	1.972	2.645	3.384	0.65
169	0.914	0.200	1.618	0.333	2.537	0.828	13.702	5.730	23.751	7.136	39.028	15.699	2.013	2.746	3.467	0.65
170	0.916	0.220	1.636	0.343	2.571	0.855	14.139	6.051	24.842	7.320	40.406	16.073	2.100	2.778	3.565	0.66
171	0.919	0.236	1.666	0.356	2.625	0.869	14.964	6.333	25.410	7.685	41.379	16.475	2.200	2.792	3.640	0.66
172	0.931	0.247	1.685	0.385	2.657	0.885	15.704	6.490	25.798	8.052	42.033	17.158	2.251	2.810	3.718	0.67
173	0.948	0.257	1.726	0.409	2.683	0.900	16.253	6.796	26.122	8.344	42.432	17.532	2.270	2.847	3.781	0.67
174	0.983	0.267	1.742	0.433	2.701	0.941	16.907	7.205	26.353	8.602	42.742	17.965	2.301	2.874	3.827	0.68
175	1.018	0.283	1.756	0.453	2.717	0.979	17.655	8.151	26.638	8.898	43.399	18.242	2.318	2.905	3.852	0.68
176	1.027	0.295	1.769	0.463	2.732	1.002	18.020	8.230	27.219	9.251	43.895	18.283	2.335	2.950	3.903	0.68
177	1.035	0.312	1.784	0.507	2.756	1.025	18.349	8.584	27.279	10.253	44.227	18.480	2.349	3.001	3.930	0.68
178	1.051	0.318	1.802	0.523	2.781	1.047	18.671	8.800	27.320	10.828	44.926	19.576	2.387	3.047	3.970	0.68
179	1.074	0.323	1.822	0.528	2.811	1.065	18.972	8.847	27.352	10.933	45.256	20.015	2.423	3.104	4.015	0.68
180	1.084	0.337	1.843	0.541	2.853	1.089	19.228	8.913	27.822	11.060	45.553	20.203	2.462	3.173	4.074	0.68
181	1.099	0.345	1.864	0.549	2.898	1.109	20.123	9.122	28.763	11.188	45.753	20.433	2.503	3.238	4.159	0.68
182	1.121	0.350	1.884	0.559	2.946	1.133	20.405	9.532	29.402	11.345	46.210	21.025	2.545	3.302	4.230	0.68
183	1.132	0.359	1.896	0.571	2.988	1.158	20.754	10.256	29.971	11.733	47.017	21.882	2.586	3.372	4.286	0.68
184	1.152	0.387	1.915	0.584	3.023	1.184	21.684	10.862	30.276	12.598	48.185	22.204	2.627	3.452	4.334	0.68
185	1.161	0.398	1.940	0.598	3.057	1.209	21.955	10.996	30.988	12.953	48.741	22.859	2.673	3.545	4.388	0.68

186	1.168	0.400	1.958	0.613	3.076	1.222	22.650	11.206	31.095	13.213	49.462	23.533	2.749	3.648	4.447	0.69
187	1.175	0.402	1.972	0.624	3.101	1.231	22.989	11.514	31.314	14.131	50.313	24.281	2.804	3.701	4.505	0.70
188	1.181	0.405	1.985	0.629	3.120	1.239	23.535	11.894	31.833	14.839	51.285	25.078	2.851	3.759	4.561	0.72
189	1.188	0.418	1.991	0.629	3.136	1.254	23.876	12.019	32.239	15.137	52.076	25.276	2.894	3.821	4.625	0.72
190	1.203	0.429	1.993	0.638	3.151	1.278	24.018	12.170	32.547	15.138	52.857	25.578	2.931	3.870	4.696	0.73
191	1.219	0.442	1.995	0.648	3.163	1.300	24.464	12.517	32.855	15.141	52.876	25.859	2.971	3.892	4.731	0.73
192	1.233	0.457	2.001	0.659	3.209	1.313	24.685	12.598	33.153	15.595	53.067	25.985	3.020	3.914	4.780	0.74
193	1.251	0.473	2.015	0.663	3.223	1.324	24.931	12.625	33.444	15.658	53.777	26.153	3.077	3.955	4.837	0.74
194	1.255	0.487	2.031	0.671	3.237	1.340	25.188	12.653	33.482	15.704	54.242	26.582	3.132	3.997	4.876	0.74
195	1.258	0.501	2.047	0.681	3.263	1.367	25.468	12.777	33.516	15.729	54.489	27.067	3.185	4.035	4.928	0.75
196	1.265	0.510	2.063	0.693	3.302	1.387	25.627	12.906	33.549	16.058	54.601	27.456	3.219	4.089	4.972	0.76
197	1.280	0.512	2.079	0.709	3.338	1.402	25.746	12.989	33.653	16.987	54.912	27.805	3.268	4.146	5.025	0.76
198	1.293	0.514	2.094	0.725	3.372	1.417	25.850	13.060	33.973	17.064	55.588	28.070	3.299	4.206	5.104	0.76
199	1.301	0.516	2.109	0.740	3.390	1.432	25.974	13.165	34.159	17.073	56.266	28.590	3.350	4.243	5.189	0.76
200	1.313	0.518	2.122	0.754	3.428	1.446	26.141	13.242	34.191	17.153	56.617	28.914	3.406	4.295	5.275	0.77
201	1.324	0.527	2.130	0.767	3.470	1.460	26.225	13.412	34.250	17.332	56.863	29.063	3.466	4.351	5.336	0.77
202	1.332	0.540	2.137	0.775	3.493	1.477	26.338	13.662	34.469	17.406	57.204	29.502	3.497	4.398	5.366	0.77
203	1.341	0.547	2.157	0.787	3.509	1.492	26.547	13.773	34.716	17.641	57.371	29.697	3.514	4.410	5.387	0.78
204	1.357	0.553	2.172	0.795	3.522	1.501	26.818	13.942	34.969	17.922	57.487	29.713	3.517	4.419	5.427	0.79
205	1.375	0.559	2.194	0.803	3.533	1.510	27.052	14.090	35.144	18.484	57.728	29.783	3.519	4.426	5.444	0.79
206	1.392	0.563	2.222	0.854	3.550	1.522	27.393	14.224	35.418	18.553	58.097	29.942	3.523	4.429	5.447	0.80
207	1.408	0.567	2.245	0.859	3.578	1.561	27.501	14.426	35.766	18.658	58.572	30.284	3.545	4.453	5.477	0.81
208	1.422	0.571	2.268	0.872	3.607	1.585	27.632	14.498	35.949	18.953	59.024	30.755	3.570	4.486	5.520	0.81
209	1.433	0.575	2.279	0.892	3.630	1.597	27.803	14.776	36.010	19.266	59.321	31.287	3.600	4.542	5.560	0.82
210	1.443	0.579	2.288	0.896	3.658	1.607	27.953	14.907	36.548	19.309	59.715	31.549	3.619	4.598	5.603	0.83
211	1.453	0.595	2.301	0.903	3.701	1.627	28.205	14.916	37.179	19.731	60.045	31.820	3.639	4.638	5.657	0.83
212	1.463	0.605	2.316	0.924	3.745	1.645	28.543	15.014	37.651	19.902	60.453	32.250	3.686	4.715	5.698	0.84
213	1.468	0.614	2.332	0.938	3.778	1.656	28.997	15.221	38.041	20.012	60.935	32.546	3.732	4.774	5.762	0.85
214	1.470	0.622	2.345	0.941	3.814	1.663	29.000	15.472	38.591	20.260	61.307	32.808	3.791	4.829	5.827	0.85
215	1.474	0.627	2.354	0.951	3.825	1.669	29.005	15.555	38.852	20.739	61.666	33.060	3.833	4.872	5.849	0.85
216	1.478	0.638	2.362	0.966	3.835	1.674	29.081	15.652	38.861	21.346	62.148	33.204	3.890	4.931	5.884	0.86
217	1.481	0.643	2.368	0.979	3.844	1.685	29.281	15.969	38.926	21.810	62.532	33.341	3.932	4.960	5.908	0.86
218	1.484	0.643	2.376	0.980	3.853	1.700	29.483	16.028	39.194	22.001	62.546	33.414	3.960	4.963	5.921	0.87
219	1.487	0.645	2.384	0.981	3.864	1.704	29.734	16.375	39.474	22.290	62.559	33.514	3.997	4.965	5.931	0.87
220	1.490	0.651	2.391	1.005	3.874	1.706	29.803	16.487	39.668	22.324	62.570	33.640	4.013	4.968	5.939	0.88
221	1.493	0.655	2.395	1.016	3.891	1.709	29.821	16.524	39.781	22.343	62.846	33.692	4.035	4.971	5.947	0.88
222	1.504	0.663	2.400	1.022	3.928	1.711	29.847	16.578	39.890	22.522	63.097	33.711	4.038	4.974	5.952	0.88
223	1.522	0.671	2.405	1.028	3.966	1.714	29.862	16.684	39.954	22.661	63.150	33.733	4.050	4.977	5.955	0.89
224	1.547	0.675	2.409	1.035	4.008	1.718	29.873	16.755	39.984	22.666	63.150	33.770	4.066	4.979	5.957	0.90
225	1.549	0.684	2.413	1.041	4.010	1.721	30.008	16.770	39.989	22.667	63.150	33.796	4.070	4.980	5.959	0.90
226	1.562	0.694	2.415	1.045	4.012	1.723	30.126	16.805	39.990	22.668	63.150	33.810	4.072	4.981	5.961	0.91
227	1.574	0.701	2.417	1.051	4.016	1.726	30.127	16.865	39.990	22.669	63.150	33.821	4.072	4.982	5.963	0.91
228	1.579	0.702	2.419	1.055	4.019	1.729	30.127	16.960	39.990	22.670	63.150	33.839	4.073	4.983	5.966	0.92
229	1.584	0.708	2.420	1.059	4.057	1.731	30.208	16.960	39.991	22.671	63.150	33.865	4.073	4.984	5.971	0.92
230	1.589	0.708	2.421	1.062	4.065	1.733	30.314	16.962	40.012	22.671	63.150	33.894	4.073	4.985	5.977	0.92
231	1.590	0.709	2.423	1.063	4.071	1.735	30.323	16.988	40.061	22.672	63.150	33.918	4.073	4.986	5.984	0.92
232	1.596	0.710	2.425	1.063	4.073	1.743	30.325	17.072	40.116	22.673	63.150	33.944	4.074	4.987	5.990	0.93
233	1.598	0.710	2.427	1.063	4.075	1.749	30.368	17.094	40.249	22.673	63.150	33.985	4.074	4.988	5.997	0.93
234	1.604	0.711	2.429	1.064	4.077	1.753	30.411	17.184	40.253	22.673	63.153	34.014	4.075	4.989	6.004	0.93
235	1.610	0.712	2.430	1.064	4.079	1.757	30.416	17.187	40.290	22.674	63.159	34.032	4.075	4.990	6.012	0.93
236	1.612	0.712	2.431	1.066	4.081	1.762	30.428	17.188	40.385	22.675	63.173	34.051	4.076	4.991	6.024	0.94
237	1.613	0.712	2.432	1.069	4.083	1.767	30.430	17.189	40.488	22.675	63.193	34.067	4.076	4.992	6.037	0.94
238	1.614	0.713	2.433	1.072	4.084	1.772	30.452	17.241	40.720	22.675	63.214	34.079	4.076	4.993	6.049	0.94
239	1.615	0.716	2.434	1.075	4.085	1.776	30.488	17.370	40.763	22.677	63.233	34.085	4.076	4.994	6.060	0.94

Appendix B

Alternative Fast-Pass IM240 Standards

Alternative Fast-Pass IM240 Standards
Corresponding to Composite Start-up Emission Standards
in §85.2205(a)(2)(i) and §85.2205(a)(2)(ii)

Light Duty Vehicles

	Low Altitude 1981-1982			Low Altitude 1983-1990			Low Altitude 1991-1995			High Altitude 1982		
Sec	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
30	0.330	4.189	0.250	0.330	1.941	0.251	0.174	1.307	0.222	0.330	7.391	0.250
31	0.342	4.278	0.267	0.342	1.983	0.268	0.179	1.329	0.246	0.342	7.667	0.267
32	0.353	4.366	0.283	0.353	2.025	0.285	0.184	1.350	0.270	0.353	7.944	0.283
33	0.364	4.455	0.300	0.365	2.067	0.302	0.189	1.372	0.294	0.364	8.220	0.300
34	0.375	4.544	0.316	0.376	2.108	0.320	0.194	1.394	0.318	0.375	8.497	0.316
35	0.386	4.633	0.333	0.388	2.150	0.337	0.199	1.416	0.342	0.386	8.773	0.333
36	0.398	4.728	0.336	0.399	2.230	0.339	0.201	1.453	0.345	0.398	9.011	0.336
37	0.409	4.823	0.339	0.410	2.310	0.342	0.203	1.490	0.348	0.409	9.249	0.339
38	0.420	4.917	0.342	0.420	2.390	0.344	0.205	1.527	0.350	0.420	9.488	0.342
39	0.431	5.012	0.345	0.431	2.471	0.347	0.207	1.565	0.353	0.431	9.726	0.345
40	0.443	5.107	0.348	0.442	2.551	0.349	0.209	1.602	0.356	0.443	9.964	0.348
41	0.458	5.429	0.371	0.458	2.738	0.373	0.214	1.642	0.373	0.458	10.527	0.371
42	0.474	5.751	0.394	0.473	2.926	0.397	0.219	1.682	0.390	0.474	11.090	0.394
43	0.489	6.073	0.418	0.489	3.114	0.422	0.224	1.722	0.407	0.489	11.652	0.418
44	0.505	6.395	0.441	0.505	3.302	0.446	0.228	1.763	0.425	0.505	12.215	0.441
45	0.521	6.717	0.465	0.520	3.489	0.470	0.233	1.803	0.442	0.521	12.778	0.465
46	0.535	6.985	0.480	0.536	3.589	0.486	0.238	1.867	0.465	0.535	13.265	0.480
47	0.550	7.254	0.496	0.552	3.688	0.501	0.244	1.932	0.487	0.550	13.751	0.496
48	0.565	7.522	0.512	0.568	3.787	0.517	0.250	1.997	0.510	0.565	14.238	0.512
49	0.580	7.791	0.527	0.584	3.887	0.533	0.255	2.061	0.533	0.580	14.724	0.527
50	0.594	8.060	0.543	0.600	3.986	0.549	0.261	2.126	0.555	0.594	15.211	0.543
51	0.611	8.511	0.567	0.617	4.029	0.571	0.268	2.152	0.573	0.611	15.550	0.567
52	0.628	8.962	0.590	0.633	4.072	0.594	0.275	2.179	0.590	0.628	15.889	0.590
53	0.644	9.413	0.613	0.649	4.115	0.616	0.282	2.205	0.608	0.644	16.228	0.613
54	0.661	9.865	0.637	0.665	4.157	0.638	0.290	2.232	0.625	0.661	16.567	0.637
55	0.678	10.316	0.660	0.681	4.200	0.661	0.297	2.258	0.643	0.678	16.907	0.660
56	0.691	10.818	0.675	0.696	4.263	0.676	0.302	2.348	0.654	0.691	17.199	0.675
57	0.705	11.320	0.689	0.710	4.326	0.691	0.306	2.437	0.666	0.705	17.492	0.689
58	0.718	11.822	0.703	0.725	4.388	0.707	0.311	2.526	0.677	0.718	17.785	0.703
59	0.731	12.325	0.718	0.740	4.451	0.722	0.316	2.616	0.688	0.731	18.078	0.718
60	0.745	12.827	0.732	0.754	4.514	0.737	0.320	2.705	0.700	0.745	18.371	0.732
61	0.758	13.228	0.743	0.767	4.589	0.748	0.323	2.726	0.707	0.758	18.609	0.743
62	0.772	13.629	0.754	0.780	4.664	0.758	0.326	2.746	0.714	0.772	18.847	0.754
63	0.786	14.029	0.764	0.794	4.740	0.769	0.329	2.767	0.722	0.786	19.085	0.764
64	0.799	14.430	0.775	0.807	4.815	0.780	0.332	2.787	0.729	0.799	19.323	0.775
65	0.813	14.831	0.786	0.820	4.891	0.790	0.335	2.808	0.736	0.813	19.562	0.786
66	0.827	15.046	0.794	0.833	4.945	0.799	0.340	2.812	0.742	0.827	19.887	0.794
67	0.841	15.261	0.803	0.846	4.999	0.808	0.345	2.816	0.747	0.841	20.213	0.803
68	0.855	15.476	0.811	0.859	5.053	0.817	0.350	2.820	0.753	0.855	20.539	0.811
69	0.869	15.692	0.820	0.872	5.107	0.826	0.355	2.825	0.758	0.869	20.865	0.820
70	0.883	15.907	0.828	0.885	5.162	0.835	0.360	2.829	0.764	0.883	21.191	0.828
71	0.894	16.118	0.838	0.896	5.226	0.846	0.364	2.847	0.783	0.894	21.396	0.838
72	0.905	16.330	0.848	0.906	5.291	0.857	0.367	2.865	0.802	0.905	21.602	0.848
73	0.917	16.542	0.858	0.917	5.356	0.868	0.371	2.884	0.822	0.917	21.808	0.858
74	0.928	16.753	0.868	0.928	5.421	0.878	0.375	2.902	0.841	0.928	22.013	0.868
75	0.939	16.965	0.878	0.939	5.486	0.889	0.378	2.921	0.860	0.939	22.219	0.878
76	0.953	17.199	0.891	0.952	5.553	0.900	0.387	2.982	0.874	0.953	22.685	0.891
77	0.967	17.432	0.904	0.965	5.620	0.911	0.396	3.044	0.888	0.967	23.151	0.904
78	0.981	17.666	0.917	0.978	5.687	0.922	0.405	3.106	0.902	0.981	23.617	0.917
79	0.994	17.900	0.930	0.991	5.754	0.933	0.414	3.167	0.916	0.994	24.083	0.930
80	1.008	18.133	0.944	1.004	5.821	0.944	0.423	3.229	0.930	1.008	24.549	0.944

81	1.019	18.182	0.951	1.015	5.842	0.951	0.428	3.240	0.945	1.019	24.570	0.951
82	1.031	18.231	0.958	1.026	5.863	0.959	0.432	3.250	0.959	1.031	24.591	0.958
83	1.042	18.280	0.965	1.037	5.883	0.966	0.437	3.261	0.973	1.042	24.612	0.965
84	1.053	18.329	0.972	1.048	5.904	0.973	0.441	3.271	0.987	1.053	24.633	0.972
85	1.065	18.378	0.979	1.059	5.925	0.980	0.445	3.281	1.002	1.065	24.654	0.979
86	1.072	18.393	0.980	1.067	5.970	0.981	0.448	3.290	1.003	1.072	24.666	0.980
87	1.079	18.408	0.981	1.075	6.015	0.982	0.452	3.298	1.004	1.079	24.678	0.981
88	1.086	18.423	0.982	1.083	6.060	0.982	0.455	3.306	1.005	1.086	24.690	0.982
89	1.093	18.438	0.983	1.091	6.105	0.983	0.458	3.315	1.006	1.093	24.703	0.983
90	1.099	18.453	0.983	1.099	6.151	0.984	0.462	3.323	1.007	1.099	24.715	0.983
91	1.107	18.467	0.984	1.106	6.185	0.985	0.463	3.360	1.008	1.107	24.737	0.984
92	1.114	18.481	0.985	1.114	6.219	0.986	0.464	3.397	1.008	1.114	24.758	0.985
93	1.121	18.495	0.985	1.122	6.253	0.986	0.465	3.434	1.009	1.121	24.780	0.985
94	1.128	18.509	0.986	1.129	6.287	0.987	0.466	3.470	1.009	1.128	24.801	0.986
95	1.135	18.523	0.986	1.137	6.321	0.988	0.468	3.507	1.010	1.135	24.823	0.986
96	1.149	18.681	0.992	1.150	6.489	0.993	0.472	3.536	1.011	1.149	25.193	0.992
97	1.162	18.840	0.997	1.163	6.657	0.999	0.477	3.565	1.012	1.162	25.563	0.997
98	1.176	18.998	1.002	1.176	6.825	1.004	0.481	3.594	1.013	1.176	25.933	1.002
99	1.189	19.157	1.008	1.189	6.992	1.009	0.486	3.623	1.014	1.189	26.303	1.008
100	1.203	19.315	1.013	1.202	7.160	1.014	0.490	3.651	1.015	1.203	26.672	1.013
101	1.223	20.090	1.049	1.224	7.269	1.049	0.499	3.685	1.042	1.223	27.821	1.049
102	1.244	20.864	1.085	1.245	7.378	1.084	0.509	3.719	1.069	1.244	28.969	1.085
103	1.264	21.639	1.121	1.266	7.487	1.119	0.518	3.753	1.097	1.264	30.117	1.121
104	1.285	22.414	1.157	1.287	7.596	1.154	0.527	3.787	1.124	1.285	31.265	1.157
105	1.305	23.189	1.193	1.309	7.705	1.189	0.537	3.821	1.151	1.305	32.414	1.193
106	1.319	23.461	1.224	1.323	7.835	1.215	0.541	3.842	1.194	1.319	33.103	1.224
107	1.333	23.733	1.255	1.338	7.965	1.241	0.545	3.863	1.237	1.333	33.792	1.255
108	1.346	24.006	1.286	1.352	8.095	1.267	0.548	3.884	1.280	1.346	34.481	1.286
109	1.360	24.278	1.317	1.367	8.225	1.293	0.552	3.904	1.323	1.360	35.170	1.317
110	1.374	24.550	1.348	1.382	8.355	1.319	0.556	3.925	1.366	1.374	35.859	1.348
111	1.385	24.846	1.356	1.394	8.414	1.327	0.562	3.931	1.368	1.385	36.177	1.356
112	1.396	25.141	1.363	1.406	8.472	1.336	0.568	3.937	1.371	1.396	36.495	1.363
113	1.407	25.437	1.371	1.418	8.531	1.345	0.574	3.943	1.374	1.407	36.813	1.371
114	1.417	25.732	1.378	1.430	8.590	1.354	0.580	3.949	1.377	1.417	37.132	1.378
115	1.428	26.028	1.386	1.442	8.649	1.363	0.586	3.956	1.380	1.428	37.450	1.386
116	1.437	26.045	1.388	1.451	8.735	1.364	0.590	3.975	1.380	1.437	37.554	1.388
117	1.446	26.062	1.389	1.460	8.821	1.365	0.593	3.995	1.381	1.446	37.658	1.389
118	1.455	26.079	1.391	1.469	8.907	1.366	0.597	4.015	1.382	1.455	37.761	1.391
119	1.464	26.096	1.393	1.479	8.992	1.368	0.600	4.035	1.383	1.464	37.865	1.393
120	1.472	26.114	1.394	1.488	9.078	1.369	0.604	4.055	1.383	1.472	37.969	1.394
121	1.488	26.293	1.408	1.501	9.152	1.385	0.610	4.152	1.400	1.488	38.310	1.408
122	1.503	26.472	1.422	1.514	9.227	1.401	0.615	4.250	1.417	1.503	38.650	1.422
123	1.518	26.651	1.435	1.527	9.301	1.417	0.621	4.348	1.433	1.518	38.990	1.435
124	1.534	26.830	1.449	1.540	9.375	1.434	0.627	4.445	1.450	1.534	39.330	1.449
125	1.549	27.010	1.463	1.553	9.449	1.450	0.632	4.543	1.466	1.549	39.671	1.463
126	1.559	27.151	1.471	1.563	9.519	1.458	0.636	4.567	1.470	1.559	39.865	1.471
127	1.569	27.292	1.479	1.572	9.590	1.467	0.639	4.592	1.473	1.569	40.059	1.479
128	1.579	27.433	1.487	1.582	9.661	1.475	0.642	4.617	1.476	1.579	40.254	1.487
129	1.590	27.575	1.495	1.592	9.731	1.484	0.645	4.641	1.479	1.590	40.448	1.495
130	1.600	27.716	1.502	1.601	9.802	1.492	0.648	4.666	1.482	1.600	40.642	1.502
131	1.612	27.878	1.506	1.615	9.849	1.496	0.653	4.685	1.483	1.612	40.790	1.506
132	1.624	28.040	1.509	1.628	9.895	1.500	0.657	4.704	1.485	1.624	40.937	1.509
133	1.635	28.202	1.512	1.642	9.942	1.504	0.661	4.724	1.486	1.635	41.084	1.512
134	1.647	28.365	1.515	1.655	9.989	1.508	0.666	4.743	1.488	1.647	41.231	1.515
135	1.659	28.527	1.519	1.669	10.035	1.512	0.670	4.762	1.489	1.659	41.379	1.519
136	1.676	28.833	1.542	1.685	10.104	1.534	0.678	4.785	1.507	1.676	42.023	1.542
137	1.693	29.140	1.566	1.700	10.173	1.557	0.685	4.807	1.524	1.693	42.668	1.566
138	1.709	29.446	1.589	1.716	10.241	1.580	0.693	4.830	1.541	1.709	43.312	1.589
139	1.726	29.753	1.613	1.732	10.310	1.603	0.700	4.853	1.559	1.726	43.957	1.613
140	1.743	30.060	1.636	1.747	10.378	1.626	0.708	4.875	1.576	1.743	44.602	1.636
141	1.756	30.160	1.651	1.762	10.506	1.640	0.716	4.886	1.592	1.756	45.010	1.651

 Appendix B

142	1.770	30.260	1.666	1.777	10.633	1.655	0.723	4.897	1.608	1.770	45.419	1.666
143	1.783	30.361	1.681	1.791	10.761	1.669	0.731	4.908	1.624	1.783	45.828	1.681
144	1.797	30.461	1.696	1.806	10.888	1.684	0.738	4.918	1.640	1.797	46.237	1.696
145	1.810	30.562	1.711	1.821	11.016	1.699	0.746	4.929	1.656	1.810	46.646	1.711
146	1.822	30.592	1.720	1.830	11.101	1.709	0.751	4.954	1.663	1.822	46.945	1.720
147	1.834	30.622	1.730	1.840	11.187	1.720	0.755	4.979	1.671	1.834	47.244	1.730
148	1.846	30.653	1.740	1.850	11.273	1.730	0.760	5.004	1.679	1.846	47.544	1.740
149	1.858	30.683	1.750	1.860	11.359	1.741	0.765	5.029	1.687	1.858	47.843	1.750
150	1.869	30.713	1.760	1.869	11.445	1.752	0.770	5.054	1.694	1.869	48.143	1.760
151	1.880	30.741	1.767	1.879	11.504	1.759	0.775	5.060	1.711	1.880	48.423	1.767
152	1.890	30.768	1.775	1.890	11.564	1.767	0.780	5.065	1.727	1.890	48.704	1.775
153	1.900	30.796	1.783	1.900	11.624	1.775	0.785	5.070	1.743	1.900	48.984	1.783
154	1.910	30.823	1.791	1.910	11.683	1.783	0.791	5.075	1.760	1.910	49.265	1.791
155	1.920	30.850	1.798	1.920	11.743	1.790	0.796	5.080	1.776	1.920	49.545	1.798
156	1.949	32.415	1.828	1.945	12.434	1.821	0.819	5.150	1.813	1.949	50.517	1.828
157	1.977	33.980	1.858	1.971	13.125	1.852	0.842	5.220	1.850	1.977	51.489	1.858
158	2.006	35.545	1.888	1.996	13.816	1.883	0.865	5.290	1.887	2.006	52.461	1.888
159	2.034	37.110	1.918	2.022	14.507	1.913	0.888	5.360	1.924	2.034	53.433	1.918
160	2.063	38.674	1.948	2.047	15.198	1.944	0.911	5.430	1.961	2.063	54.406	1.948
161	2.105	41.040	2.043	2.092	16.627	2.038	0.951	7.045	2.030	2.105	56.279	2.043
162	2.147	43.405	2.138	2.137	18.056	2.133	0.992	8.661	2.099	2.147	58.152	2.138
163	2.190	45.770	2.234	2.182	19.485	2.227	1.032	10.276	2.168	2.190	60.026	2.234
164	2.232	48.136	2.329	2.227	20.914	2.321	1.073	11.891	2.237	2.232	61.899	2.329
165	2.275	50.501	2.424	2.272	22.343	2.415	1.113	13.506	2.306	2.275	63.773	2.424
166	2.304	52.979	2.509	2.300	23.672	2.502	1.163	14.131	2.357	2.304	65.726	2.509
167	2.333	55.458	2.593	2.328	25.002	2.589	1.213	14.755	2.409	2.333	67.678	2.593
168	2.362	57.937	2.678	2.356	26.331	2.676	1.263	15.380	2.460	2.362	69.631	2.678
169	2.391	60.415	2.762	2.385	27.660	2.763	1.313	16.004	2.512	2.391	71.584	2.762
170	2.420	62.894	2.847	2.413	28.989	2.849	1.363	16.628	2.564	2.420	73.536	2.847
171	2.451	63.874	2.890	2.442	29.484	2.892	1.386	16.692	2.603	2.451	75.553	2.890
172	2.481	64.855	2.933	2.472	29.978	2.934	1.410	16.756	2.643	2.481	77.570	2.933
173	2.512	65.835	2.976	2.502	30.473	2.976	1.433	16.820	2.683	2.512	79.587	2.976
174	2.542	66.815	3.019	2.532	30.967	3.019	1.457	16.883	2.723	2.542	81.604	3.019
175	2.573	67.796	3.062	2.562	31.462	3.061	1.480	16.947	2.762	2.573	83.621	3.062
176	2.598	68.919	3.122	2.588	32.216	3.119	1.494	17.044	2.809	2.598	85.074	3.122
177	2.623	70.042	3.181	2.615	32.970	3.178	1.508	17.141	2.856	2.623	86.528	3.181
178	2.648	71.165	3.240	2.641	33.725	3.236	1.522	17.238	2.903	2.648	87.981	3.240
179	2.674	72.287	3.300	2.668	34.479	3.295	1.536	17.335	2.949	2.674	89.434	3.300
180	2.699	73.410	3.359	2.694	35.233	3.353	1.550	17.431	2.996	2.699	90.888	3.359
181	2.726	74.714	3.432	2.718	35.950	3.424	1.565	17.453	3.040	2.726	92.421	3.432
182	2.753	76.017	3.504	2.743	36.666	3.495	1.580	17.475	3.084	2.753	93.953	3.504
183	2.780	77.320	3.576	2.767	37.382	3.567	1.595	17.497	3.129	2.780	95.486	3.576
184	2.807	78.623	3.648	2.791	38.099	3.638	1.610	17.519	3.173	2.807	97.019	3.648
185	2.834	79.927	3.720	2.816	38.815	3.709	1.624	17.540	3.217	2.834	98.552	3.720
186	2.861	81.488	3.804	2.843	39.562	3.795	1.639	17.816	3.277	2.861	100.583	3.804
187	2.888	83.049	3.889	2.869	40.309	3.880	1.654	18.091	3.337	2.888	102.615	3.889
188	2.915	84.611	3.973	2.896	41.056	3.965	1.668	18.366	3.397	2.915	104.646	3.973
189	2.942	86.172	4.057	2.923	41.803	4.051	1.683	18.641	3.457	2.942	106.677	4.057
190	2.969	87.733	4.141	2.950	42.550	4.136	1.697	18.916	3.518	2.969	108.709	4.141
191	2.994	88.668	4.196	2.975	43.279	4.190	1.711	19.891	3.565	2.994	110.057	4.196
192	3.019	89.603	4.250	3.001	44.008	4.243	1.724	20.866	3.612	3.019	111.405	4.250
193	3.044	90.538	4.304	3.027	44.737	4.297	1.737	21.840	3.658	3.044	112.753	4.304
194	3.070	91.473	4.358	3.052	45.466	4.351	1.750	22.815	3.705	3.070	114.101	4.358
195	3.095	92.407	4.412	3.078	46.195	4.404	1.763	23.790	3.752	3.095	115.449	4.412
196	3.120	93.768	4.485	3.105	46.747	4.477	1.778	24.992	3.794	3.120	116.561	4.485
197	3.145	95.129	4.558	3.132	47.299	4.549	1.793	26.194	3.836	3.145	117.674	4.558
198	3.169	96.490	4.630	3.159	47.852	4.622	1.808	27.396	3.877	3.169	118.786	4.630
199	3.194	97.851	4.703	3.186	48.404	4.694	1.823	28.597	3.919	3.194	119.899	4.703
200	3.219	99.212	4.775	3.213	48.957	4.767	1.838	29.799	3.960	3.219	121.011	4.775
201	3.242	99.878	4.821	3.234	49.204	4.812	1.858	29.975	4.004	3.242	121.695	4.821
202	3.266	100.544	4.867	3.255	49.451	4.858	1.877	30.152	4.047	3.266	122.378	4.867

203	3.289	101.210	4.914	3.277	49.698	4.904	1.897	30.328	4.090	3.289	123.062	4.914
204	3.312	101.876	4.960	3.298	49.945	4.950	1.916	30.504	4.133	3.312	123.745	4.960
205	3.335	102.542	5.006	3.320	50.192	4.996	1.936	30.680	4.176	3.335	124.429	5.006
206	3.362	103.507	5.037	3.346	50.698	5.029	1.948	30.747	4.193	3.362	125.599	5.037
207	3.388	104.472	5.069	3.373	51.205	5.063	1.961	30.813	4.209	3.388	126.769	5.069
208	3.415	105.437	5.101	3.399	51.711	5.097	1.973	30.879	4.225	3.415	127.939	5.101
209	3.441	106.402	5.132	3.426	52.218	5.130	1.986	30.946	4.241	3.441	129.109	5.132
210	3.468	107.366	5.164	3.452	52.724	5.164	1.998	31.012	4.257	3.468	130.279	5.164
211	3.488	108.519	5.234	3.472	53.327	5.233	2.006	32.744	4.311	3.488	132.009	5.234
212	3.509	109.671	5.304	3.492	53.931	5.303	2.015	34.476	4.365	3.509	133.740	5.304
213	3.530	110.823	5.374	3.513	54.534	5.372	2.023	36.207	4.419	3.530	135.470	5.374
214	3.550	111.976	5.444	3.533	55.137	5.442	2.031	37.939	4.473	3.550	137.201	5.444
215	3.571	113.128	5.514	3.553	55.740	5.511	2.039	39.671	4.527	3.571	138.931	5.514
216	3.591	113.763	5.564	3.571	56.057	5.559	2.044	39.822	4.565	3.591	140.070	5.564
217	3.612	114.398	5.613	3.589	56.373	5.606	2.048	39.973	4.602	3.612	141.208	5.613
218	3.632	115.033	5.663	3.608	56.689	5.654	2.053	40.125	4.640	3.632	142.347	5.663
219	3.652	115.668	5.713	3.626	57.005	5.701	2.058	40.276	4.677	3.652	143.485	5.713
220	3.672	116.304	5.763	3.644	57.321	5.749	2.062	40.427	4.715	3.672	144.624	5.763
221	3.693	116.644	5.775	3.669	57.474	5.761	2.076	40.526	4.724	3.693	144.903	5.775
222	3.714	116.984	5.787	3.693	57.626	5.773	2.089	40.626	4.732	3.714	145.182	5.787
223	3.736	117.324	5.799	3.717	57.779	5.785	2.103	40.725	4.741	3.736	145.462	5.799
224	3.757	117.663	5.811	3.741	57.931	5.797	2.117	40.825	4.750	3.757	145.741	5.811
225	3.778	118.003	5.823	3.766	58.084	5.809	2.130	40.924	4.759	3.778	146.020	5.823
226	3.795	118.158	5.828	3.782	58.158	5.814	2.160	40.962	4.764	3.795	146.177	5.828
227	3.811	118.312	5.833	3.798	58.232	5.820	2.190	41.000	4.770	3.811	146.334	5.833
228	3.828	118.466	5.838	3.815	58.307	5.825	2.219	41.038	4.775	3.828	146.491	5.838
229	3.845	118.621	5.842	3.831	58.381	5.830	2.249	41.076	4.781	3.845	146.648	5.842
230	3.862	118.775	5.847	3.848	58.455	5.835	2.278	41.114	4.786	3.862	146.805	5.847
231	3.873	118.885	5.852	3.858	58.534	5.840	2.285	41.142	4.790	3.873	147.057	5.852
232	3.884	118.995	5.856	3.868	58.612	5.845	2.292	41.171	4.794	3.884	147.308	5.856
233	3.896	119.105	5.860	3.879	58.690	5.850	2.299	41.199	4.797	3.896	147.560	5.860
234	3.907	119.215	5.865	3.889	58.769	5.855	2.306	41.228	4.801	3.907	147.812	5.865
235	3.918	119.325	5.869	3.900	58.847	5.860	2.313	41.256	4.805	3.918	148.064	5.869
236	3.924	119.407	5.874	3.907	58.990	5.865	2.315	41.285	4.808	3.924	148.450	5.874
237	3.930	119.488	5.878	3.913	59.132	5.869	2.318	41.313	4.812	3.930	148.837	5.878
238	3.935	119.570	5.883	3.920	59.275	5.874	2.320	41.341	4.815	3.935	149.223	5.883
239	3.941	119.651	5.887	3.927	59.418	5.878	2.322	41.369	4.818	3.941	149.609	5.887
240	3.947	119.733	5.892	3.934	59.560	5.883	2.325	41.397	4.822	3.947	149.996	5.892

Alternative Fast-Pass IM240 Standards

Corresponding to Composite Start-up Emission Standards
in §85.2205(a)(2)(iv)

High Altitude, Light Duty Truck 1

	1982-1983			1984-1987			1988-1990			1991		
Sec	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
30	1.064	14.776	0.562	0.585	10.661	0.513	0.585	10.661	0.298	0.477	5.069	0.254
31	1.091	15.338	0.610	0.609	11.033	0.551	0.609	11.033	0.319	0.494	5.129	0.270
32	1.118	15.900	0.657	0.633	11.405	0.590	0.633	11.405	0.340	0.512	5.189	0.285
33	1.145	16.462	0.705	0.657	11.777	0.629	0.657	11.777	0.361	0.529	5.249	0.300
34	1.172	17.023	0.752	0.681	12.149	0.667	0.681	12.149	0.382	0.547	5.309	0.316
35	1.199	17.585	0.800	0.705	12.521	0.706	0.705	12.521	0.403	0.564	5.369	0.331
36	1.237	17.834	0.804	0.730	12.895	0.711	0.730	12.895	0.407	0.582	5.562	0.334
37	1.275	18.084	0.808	0.754	13.269	0.716	0.754	13.269	0.410	0.601	5.755	0.336
38	1.313	18.333	0.813	0.779	13.643	0.721	0.779	13.643	0.414	0.619	5.948	0.339
39	1.351	18.582	0.817	0.803	14.018	0.727	0.803	14.018	0.418	0.637	6.142	0.341
40	1.389	18.832	0.822	0.828	14.392	0.732	0.828	14.392	0.422	0.656	6.335	0.344
41	1.459	19.867	0.869	0.854	15.098	0.796	0.854	15.098	0.451	0.681	6.890	0.368
42	1.529	20.902	0.915	0.880	15.805	0.861	0.880	15.805	0.479	0.707	7.445	0.392
43	1.599	21.937	0.962	0.907	16.511	0.925	0.907	16.511	0.508	0.732	7.999	0.416
44	1.669	22.972	1.009	0.933	17.217	0.989	0.933	17.217	0.536	0.758	8.554	0.440
45	1.738	24.008	1.056	0.959	17.924	1.053	0.959	17.924	0.565	0.783	9.109	0.464
46	1.784	24.572	1.098	0.989	18.458	1.096	0.989	18.458	0.587	0.799	9.593	0.480
47	1.830	25.136	1.140	1.019	18.992	1.138	1.019	18.992	0.609	0.816	10.076	0.496
48	1.876	25.701	1.182	1.050	19.526	1.180	1.050	19.526	0.631	0.832	10.560	0.512
49	1.922	26.265	1.224	1.080	20.060	1.223	1.080	20.060	0.652	0.848	11.044	0.528
50	1.968	26.830	1.266	1.110	20.594	1.265	1.110	20.594	0.674	0.864	11.527	0.543
51	2.020	27.642	1.305	1.146	21.719	1.294	1.146	21.719	0.701	0.891	12.038	0.563
52	2.072	28.454	1.343	1.182	22.845	1.324	1.182	22.845	0.728	0.917	12.549	0.582
53	2.124	29.266	1.381	1.218	23.970	1.353	1.218	23.970	0.755	0.943	13.059	0.601
54	2.176	30.079	1.420	1.254	25.095	1.382	1.254	25.095	0.782	0.969	13.570	0.621
55	2.228	30.891	1.458	1.290	26.221	1.411	1.290	26.221	0.809	0.995	14.081	0.640
56	2.265	31.485	1.490	1.310	26.449	1.449	1.310	26.449	0.826	1.015	14.438	0.653
57	2.302	32.078	1.522	1.330	26.677	1.486	1.330	26.677	0.842	1.035	14.796	0.666
58	2.340	32.672	1.555	1.350	26.905	1.523	1.350	26.905	0.859	1.055	15.154	0.679
59	2.377	33.266	1.587	1.370	27.133	1.560	1.370	27.133	0.876	1.075	15.512	0.692
60	2.415	33.860	1.619	1.390	27.361	1.597	1.390	27.361	0.892	1.095	15.870	0.705
61	2.451	34.449	1.637	1.405	27.372	1.611	1.405	27.372	0.903	1.109	16.268	0.714
62	2.487	35.037	1.656	1.420	27.383	1.625	1.420	27.383	0.915	1.124	16.667	0.723
63	2.523	35.626	1.674	1.434	27.393	1.639	1.434	27.393	0.926	1.138	17.066	0.732
64	2.559	36.215	1.693	1.449	27.404	1.653	1.449	27.404	0.938	1.153	17.465	0.741
65	2.595	36.804	1.711	1.464	27.415	1.667	1.464	27.415	0.949	1.167	17.863	0.750
66	2.639	37.463	1.737	1.497	28.054	1.699	1.497	28.054	0.960	1.182	18.249	0.759
67	2.683	38.122	1.763	1.530	28.694	1.732	1.530	28.694	0.972	1.196	18.635	0.768
68	2.728	38.782	1.789	1.563	29.333	1.765	1.563	29.333	0.983	1.211	19.020	0.777
69	2.772	39.441	1.815	1.596	29.972	1.797	1.596	29.972	0.994	1.225	19.406	0.786
70	2.817	40.100	1.841	1.629	30.612	1.830	1.629	30.612	1.005	1.239	19.792	0.795
71	2.859	40.631	1.862	1.650	31.097	1.854	1.650	31.097	1.016	1.255	19.906	0.805
72	2.901	41.161	1.884	1.672	31.583	1.878	1.672	31.583	1.028	1.271	20.020	0.815
73	2.943	41.692	1.906	1.694	32.068	1.902	1.694	32.068	1.039	1.287	20.134	0.825
74	2.985	42.222	1.928	1.715	32.554	1.925	1.715	32.554	1.051	1.303	20.248	0.835
75	3.027	42.753	1.950	1.737	33.039	1.949	1.737	33.039	1.062	1.318	20.362	0.845
76	3.061	43.694	1.978	1.760	33.193	1.977	1.760	33.193	1.074	1.331	20.782	0.859
77	3.096	44.636	2.007	1.782	33.347	2.005	1.782	33.347	1.085	1.344	21.202	0.874
78	3.130	45.577	2.035	1.805	33.501	2.033	1.805	33.501	1.096	1.357	21.623	0.888
79	3.165	46.519	2.063	1.828	33.655	2.061	1.828	33.655	1.108	1.370	22.043	0.902
80	3.200	47.461	2.092	1.851	33.809	2.089	1.851	33.809	1.119	1.382	22.463	0.916
81	3.237	47.831	2.111	1.872	34.035	2.111	1.872	34.035	1.131	1.407	22.571	0.925
82	3.275	48.201	2.130	1.894	34.261	2.132	1.894	34.261	1.144	1.431	22.678	0.934
83	3.313	48.571	2.149	1.915	34.488	2.154	1.915	34.488	1.156	1.455	22.786	0.942

84	3.351	48.941	2.168	1.937	34.714	2.175	1.937	34.714	1.169	1.480	22.894	0.951
85	3.389	49.311	2.187	1.958	34.941	2.197	1.958	34.941	1.181	1.504	23.001	0.960
86	3.432	49.503	2.189	1.973	35.115	2.200	1.973	35.115	1.182	1.531	23.112	0.961
87	3.475	49.694	2.192	1.988	35.289	2.203	1.988	35.289	1.182	1.558	23.223	0.963
88	3.518	49.886	2.194	2.002	35.463	2.206	2.002	35.463	1.183	1.586	23.334	0.964
89	3.562	50.077	2.197	2.017	35.637	2.209	2.017	35.637	1.184	1.613	23.445	0.966
90	3.605	50.269	2.199	2.032	35.811	2.212	2.032	35.811	1.185	1.640	23.556	0.967
91	3.645	50.447	2.200	2.044	35.968	2.213	2.044	35.968	1.186	1.654	23.558	0.968
92	3.686	50.626	2.201	2.056	36.125	2.214	2.056	36.125	1.187	1.668	23.560	0.968
93	3.727	50.805	2.202	2.068	36.282	2.215	2.068	36.282	1.188	1.682	23.562	0.968
94	3.767	50.984	2.203	2.081	36.440	2.216	2.081	36.440	1.189	1.696	23.564	0.969
95	3.808	51.162	2.204	2.093	36.597	2.217	2.093	36.597	1.190	1.710	23.567	0.969
96	3.853	51.779	2.212	2.111	36.968	2.227	2.111	36.968	1.195	1.727	23.924	0.978
97	3.898	52.395	2.219	2.129	37.339	2.236	2.129	37.339	1.201	1.744	24.282	0.987
98	3.943	53.012	2.227	2.147	37.710	2.245	2.147	37.710	1.207	1.762	24.639	0.996
99	3.988	53.628	2.234	2.165	38.081	2.254	2.165	38.081	1.213	1.779	24.997	1.004
100	4.033	54.245	2.242	2.183	38.453	2.263	2.183	38.453	1.218	1.796	25.355	1.013
101	4.081	55.131	2.322	2.221	40.429	2.342	2.221	40.429	1.259	1.819	25.871	1.045
102	4.128	56.016	2.403	2.258	42.405	2.420	2.258	42.405	1.299	1.842	26.387	1.076
103	4.175	56.902	2.484	2.295	44.382	2.498	2.295	44.382	1.340	1.865	26.903	1.107
104	4.223	57.788	2.565	2.333	46.358	2.576	2.333	46.358	1.380	1.887	27.419	1.139
105	4.270	58.674	2.646	2.370	48.335	2.654	2.370	48.335	1.421	1.910	27.935	1.170
106	4.300	59.222	2.721	2.404	49.060	2.740	2.404	49.060	1.458	1.936	28.221	1.201
107	4.331	59.771	2.797	2.437	49.785	2.826	2.437	49.785	1.495	1.962	28.506	1.232
108	4.361	60.319	2.872	2.471	50.511	2.912	2.471	50.511	1.531	1.988	28.792	1.263
109	4.391	60.868	2.948	2.504	51.236	2.998	2.504	51.236	1.568	2.014	29.077	1.294
110	4.421	61.416	3.023	2.538	51.962	3.084	2.538	51.962	1.605	2.040	29.363	1.325
111	4.449	61.935	3.038	2.560	52.113	3.101	2.560	52.113	1.615	2.057	29.405	1.332
112	4.476	62.455	3.053	2.582	52.265	3.118	2.582	52.265	1.624	2.074	29.447	1.338
113	4.503	62.974	3.067	2.604	52.417	3.136	2.604	52.417	1.634	2.090	29.489	1.344
114	4.531	63.493	3.082	2.625	52.569	3.153	2.625	52.569	1.644	2.107	29.531	1.350
115	4.558	64.013	3.097	2.647	52.721	3.170	2.647	52.721	1.653	2.124	29.573	1.357
116	4.600	64.559	3.099	2.673	52.723	3.173	2.673	52.723	1.656	2.152	29.865	1.359
117	4.642	65.105	3.102	2.698	52.724	3.175	2.698	52.724	1.658	2.179	30.157	1.361
118	4.684	65.651	3.105	2.723	52.726	3.178	2.723	52.726	1.661	2.207	30.449	1.363
119	4.726	66.197	3.108	2.749	52.728	3.181	2.749	52.728	1.663	2.234	30.741	1.365
120	4.768	66.743	3.111	2.774	52.729	3.184	2.774	52.729	1.666	2.262	31.033	1.368
121	4.804	67.600	3.134	2.799	53.168	3.206	2.799	53.168	1.684	2.276	31.230	1.383
122	4.840	68.458	3.156	2.824	53.606	3.229	2.824	53.606	1.703	2.290	31.428	1.399
123	4.876	69.315	3.179	2.850	54.044	3.251	2.850	54.044	1.722	2.304	31.625	1.415
124	4.911	70.173	3.202	2.875	54.483	3.274	2.875	54.483	1.741	2.318	31.823	1.431
125	4.947	71.030	3.224	2.900	54.921	3.296	2.900	54.921	1.759	2.332	32.020	1.446
126	4.983	71.729	3.241	2.920	55.078	3.310	2.920	55.078	1.770	2.355	32.099	1.453
127	5.019	72.427	3.257	2.941	55.236	3.323	2.941	55.236	1.780	2.377	32.178	1.460
128	5.055	73.126	3.274	2.961	55.393	3.337	2.961	55.393	1.790	2.399	32.256	1.468
129	5.091	73.825	3.290	2.981	55.551	3.350	2.981	55.551	1.800	2.422	32.335	1.475
130	5.126	74.523	3.307	3.001	55.708	3.364	3.001	55.708	1.811	2.444	32.413	1.482
131	5.178	75.331	3.311	3.027	55.921	3.370	3.027	55.921	1.813	2.464	32.638	1.484
132	5.230	76.139	3.316	3.052	56.134	3.376	3.052	56.134	1.816	2.485	32.862	1.487
133	5.282	76.947	3.321	3.078	56.346	3.382	3.078	56.346	1.819	2.505	33.086	1.490
134	5.334	77.755	3.326	3.103	56.559	3.388	3.103	56.559	1.822	2.525	33.310	1.492
135	5.386	78.563	3.331	3.129	56.771	3.394	3.129	56.771	1.825	2.545	33.534	1.495
136	5.468	79.372	3.365	3.167	57.854	3.432	3.167	57.854	1.851	2.573	34.147	1.520
137	5.549	80.181	3.398	3.206	58.937	3.469	3.206	58.937	1.877	2.600	34.760	1.546
138	5.630	80.990	3.431	3.244	60.020	3.507	3.244	60.020	1.903	2.628	35.373	1.571
139	5.712	81.798	3.464	3.283	61.102	3.544	3.283	61.102	1.929	2.655	35.985	1.596
140	5.793	82.607	3.498	3.322	62.185	3.582	3.322	62.185	1.955	2.682	36.598	1.622
141	5.825	83.486	3.536	3.342	62.366	3.639	3.342	62.366	1.977	2.702	36.880	1.639
142	5.856	84.365	3.575	3.363	62.548	3.697	3.363	62.548	1.999	2.722	37.162	1.656
143	5.888	85.245	3.613	3.383	62.729	3.754	3.383	62.729	2.021	2.742	37.444	1.673
144	5.920	86.124	3.652	3.404	62.910	3.811	3.404	62.910	2.043	2.762	37.727	1.691
145	5.951	87.003	3.690	3.425	63.091	3.869	3.425	63.091	2.065	2.782	38.009	1.708

146	5.975	87.915	3.718	3.453	63.539	3.892	3.453	63.539	2.074	2.797	38.632	1.717
147	5.998	88.827	3.745	3.482	63.987	3.916	3.482	63.987	2.082	2.811	39.255	1.726
148	6.022	89.739	3.772	3.510	64.435	3.939	3.510	64.435	2.090	2.825	39.878	1.735
149	6.046	90.652	3.800	3.539	64.883	3.963	3.539	64.883	2.098	2.839	40.501	1.743
150	6.069	91.564	3.827	3.568	65.331	3.986	3.568	65.331	2.106	2.853	41.124	1.752
151	6.099	92.475	3.852	3.595	65.704	4.000	3.595	65.704	2.117	2.868	41.450	1.765
152	6.129	93.387	3.877	3.623	66.077	4.014	3.623	66.077	2.129	2.883	41.776	1.778
153	6.159	94.298	3.901	3.650	66.450	4.029	3.650	66.450	2.141	2.898	42.102	1.791
154	6.189	95.209	3.926	3.677	66.823	4.043	3.677	66.823	2.152	2.913	42.428	1.803
155	6.219	96.121	3.951	3.705	67.197	4.057	3.705	67.197	2.164	2.927	42.754	1.816
156	6.313	97.599	4.030	3.767	69.206	4.117	3.767	69.206	2.205	2.969	44.233	1.849
157	6.407	99.077	4.110	3.829	71.215	4.176	3.829	71.215	2.247	3.011	45.712	1.882
158	6.501	100.555	4.190	3.891	73.225	4.236	3.891	73.225	2.289	3.053	47.191	1.915
159	6.595	102.033	4.269	3.953	75.234	4.295	3.953	75.234	2.330	3.095	48.670	1.948
160	6.689	103.511	4.349	4.015	77.243	4.355	4.015	77.243	2.372	3.136	50.149	1.981
161	7.010	107.552	4.542	4.078	79.985	4.551	4.078	79.985	2.472	3.182	51.569	2.071
162	7.331	111.593	4.736	4.142	82.727	4.747	4.142	82.727	2.571	3.227	52.988	2.162
163	7.652	115.634	4.930	4.205	85.469	4.943	4.205	85.469	2.671	3.272	54.408	2.252
164	7.972	119.676	5.123	4.268	88.211	5.139	4.268	88.211	2.770	3.318	55.828	2.343
165	8.293	123.717	5.317	4.332	90.953	5.335	4.332	90.953	2.870	3.363	57.247	2.434
166	8.576	125.252	5.496	4.380	93.266	5.516	4.380	93.266	2.961	3.410	58.958	2.509
167	8.859	126.786	5.676	4.428	95.579	5.696	4.428	95.579	3.053	3.458	60.670	2.584
168	9.142	128.321	5.855	4.477	97.892	5.876	4.477	97.892	3.144	3.505	62.381	2.659
169	9.425	129.855	6.034	4.525	100.205	6.056	4.525	100.205	3.235	3.552	64.092	2.735
170	9.708	131.390	6.213	4.573	102.517	6.237	4.573	102.517	3.327	3.600	65.804	2.810
171	9.788	132.095	6.318	4.618	103.813	6.345	4.618	103.813	3.373	3.644	66.939	2.863
172	9.868	132.801	6.422	4.664	105.109	6.452	4.664	105.109	3.420	3.688	68.075	2.916
173	9.948	133.506	6.527	4.709	106.404	6.560	4.709	106.404	3.467	3.732	69.210	2.969
174	10.028	134.211	6.632	4.754	107.700	6.668	4.754	107.700	3.513	3.776	70.345	3.022
175	10.107	134.917	6.736	4.799	108.995	6.776	4.799	108.995	3.560	3.821	71.481	3.075
176	10.174	137.703	6.876	4.858	110.733	6.910	4.858	110.733	3.626	3.856	73.077	3.130
177	10.242	140.490	7.016	4.917	112.471	7.045	4.917	112.471	3.692	3.891	74.674	3.185
178	10.309	143.276	7.155	4.977	114.209	7.179	4.977	114.209	3.758	3.927	76.271	3.240
179	10.376	146.063	7.295	5.036	115.946	7.313	5.036	115.946	3.824	3.962	77.867	3.295
180	10.443	148.849	7.435	5.095	117.684	7.447	5.095	117.684	3.889	3.997	79.464	3.350
181	10.506	152.900	7.603	5.158	119.775	7.621	5.158	119.775	3.979	4.024	81.282	3.430
182	10.570	156.950	7.772	5.221	121.866	7.795	5.221	121.866	4.069	4.050	83.100	3.509
183	10.634	161.001	7.941	5.284	123.956	7.969	5.284	123.956	4.159	4.077	84.919	3.589
184	10.698	165.051	8.110	5.347	126.047	8.143	5.347	126.047	4.248	4.104	86.737	3.668
185	10.761	169.102	8.279	5.411	128.138	8.318	5.411	128.138	4.338	4.131	88.555	3.748
186	10.836	171.850	8.477	5.428	129.673	8.499	5.428	129.673	4.443	4.154	90.333	3.841
187	10.911	174.598	8.675	5.446	131.209	8.681	5.446	131.209	4.547	4.178	92.110	3.934
188	10.986	177.345	8.873	5.463	132.745	8.862	5.463	132.745	4.652	4.202	93.888	4.026
189	11.061	180.093	9.071	5.481	134.281	9.043	5.481	134.281	4.756	4.225	95.665	4.119
190	11.136	182.841	9.269	5.499	135.816	9.225	5.499	135.816	4.861	4.249	97.442	4.212
191	11.307	184.591	9.422	5.561	137.198	9.386	5.561	137.198	4.932	4.285	98.856	4.274
192	11.477	186.341	9.576	5.623	138.580	9.547	5.623	138.580	5.003	4.321	100.271	4.336
193	11.648	188.091	9.730	5.686	139.961	9.708	5.686	139.961	5.074	4.357	101.685	4.398
194	11.819	189.841	9.884	5.748	141.343	9.869	5.748	141.343	5.146	4.393	103.099	4.459
195	11.990	191.591	10.038	5.810	142.724	10.030	5.810	142.724	5.217	4.430	104.513	4.521
196	12.067	194.037	10.193	5.828	144.052	10.188	5.828	144.052	5.301	4.460	106.134	4.589
197	12.144	196.482	10.348	5.845	145.381	10.346	5.845	145.381	5.385	4.490	107.755	4.658
198	12.221	198.927	10.503	5.863	146.709	10.504	5.863	146.709	5.469	4.520	109.376	4.726
199	12.298	201.373	10.658	5.880	148.037	10.662	5.880	148.037	5.553	4.550	110.997	4.795
200	12.376	203.818	10.813	5.898	149.365	10.820	5.898	149.365	5.637	4.580	112.617	4.863
201	12.463	204.868	10.912	5.942	150.214	10.948	5.942	150.214	5.692	4.623	113.207	4.906
202	12.551	205.918	11.012	5.986	151.063	11.075	5.986	151.063	5.746	4.666	113.796	4.949
203	12.639	206.967	11.111	6.029	151.912	11.203	6.029	151.912	5.801	4.709	114.385	4.993
204	12.726	208.017	11.211	6.073	152.760	11.330	6.073	152.760	5.856	4.752	114.974	5.036
205	12.814	209.067	11.310	6.117	153.609	11.458	6.117	153.609	5.911	4.795	115.563	5.079
206	12.891	211.915	11.381	6.174	154.888	11.530	6.174	154.888	5.951	4.848	116.847	5.119
207	12.969	214.764	11.452	6.231	156.166	11.601	6.231	156.166	5.990	4.901	118.131	5.160

208	13.046	217.612	11.523	6.288	157.445	11.673	6.288	157.445	6.030	4.955	119.415	5.201
209	13.124	220.460	11.594	6.345	158.724	11.745	6.345	158.724	6.070	5.008	120.699	5.241
210	13.201	223.309	11.665	6.401	160.002	11.817	6.401	160.002	6.110	5.061	121.983	5.282
211	13.243	226.365	11.862	6.451	161.606	11.984	6.451	161.606	6.194	5.090	123.498	5.355
212	13.285	229.421	12.060	6.500	163.210	12.152	6.500	163.210	6.278	5.119	125.012	5.429
213	13.327	232.478	12.257	6.550	164.814	12.319	6.550	164.814	6.362	5.147	126.526	5.502
214	13.370	235.534	12.455	6.599	166.418	12.486	6.599	166.418	6.446	5.176	128.040	5.576
215	13.412	238.591	12.653	6.649	168.022	12.653	6.649	168.022	6.530	5.204	129.554	5.649
216	13.470	240.891	12.778	6.693	168.948	12.780	6.693	168.948	6.585	5.240	130.345	5.695
217	13.528	243.191	12.904	6.737	169.874	12.906	6.737	169.874	6.640	5.275	131.136	5.741
218	13.586	245.492	13.030	6.782	170.800	13.032	6.782	170.800	6.695	5.310	131.928	5.787
219	13.645	247.792	13.156	6.826	171.726	13.159	6.826	171.726	6.750	5.345	132.719	5.833
220	13.703	250.092	13.282	6.870	172.653	13.285	6.870	172.653	6.804	5.380	133.510	5.879
221	13.896	250.710	13.307	6.946	173.200	13.314	6.946	173.200	6.818	5.436	133.899	5.888
222	14.088	251.329	13.332	7.022	173.748	13.343	7.022	173.748	6.831	5.492	134.287	5.896
223	14.281	251.947	13.358	7.098	174.295	13.371	7.098	174.295	6.844	5.548	134.676	5.905
224	14.474	252.565	13.383	7.173	174.843	13.400	7.173	174.843	6.857	5.604	135.064	5.913
225	14.667	253.184	13.409	7.249	175.391	13.429	7.249	175.391	6.870	5.660	135.453	5.922
226	14.845	253.888	13.422	7.334	175.611	13.440	7.334	175.611	6.877	5.699	135.633	5.927
227	15.023	254.593	13.436	7.419	175.831	13.452	7.419	175.831	6.884	5.738	135.814	5.931
228	15.201	255.297	13.450	7.504	176.051	13.464	7.504	176.051	6.891	5.776	135.995	5.936
229	15.379	256.002	13.464	7.589	176.271	13.475	7.589	176.271	6.897	5.815	136.176	5.941
230	15.557	256.706	13.478	7.674	176.491	13.487	7.674	176.491	6.904	5.854	136.356	5.946
231	15.658	257.286	13.488	7.710	176.612	13.498	7.710	176.612	6.910	5.875	136.581	5.951
232	15.759	257.866	13.499	7.746	176.732	13.508	7.746	176.732	6.916	5.897	136.806	5.956
233	15.861	258.445	13.510	7.782	176.853	13.519	7.782	176.853	6.922	5.918	137.031	5.962
234	15.962	259.025	13.521	7.818	176.974	13.530	7.818	176.974	6.928	5.940	137.256	5.967
235	16.063	259.605	13.531	7.853	177.095	13.540	7.853	177.095	6.934	5.961	137.482	5.972
236	16.104	259.940	13.543	7.867	177.463	13.551	7.867	177.463	6.940	5.977	137.680	5.978
237	16.144	260.276	13.554	7.881	177.830	13.561	7.881	177.830	6.946	5.994	137.879	5.983
238	16.185	260.612	13.566	7.894	178.198	13.572	7.894	178.198	6.951	6.010	138.078	5.989
239	16.225	260.947	13.577	7.908	178.566	13.582	7.908	178.566	6.957	6.026	138.277	5.994
240	16.265	261.283	13.589	7.922	178.933	13.592	7.922	178.933	6.962	6.042	138.476	6.000

Alternative Fast-Pass IM240 Standards

Corresponding to Composite Start-up Emission Standards
in §85.2205(a)(2)(vi)

High Altitude, Light Duty Truck 2

	1982-1983			1984-1987			1988-1990			1991		
Sec	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
30	1.064	14.776	0.513	0.585	10.661	0.513	0.585	10.661	0.436	0.477	5.069	0.395
31	1.091	15.338	0.551	0.609	11.033	0.551	0.609	11.033	0.463	0.494	5.129	0.420
32	1.118	15.900	0.590	0.633	11.405	0.590	0.633	11.405	0.490	0.512	5.189	0.445
33	1.145	16.462	0.629	0.657	11.777	0.629	0.657	11.777	0.517	0.529	5.249	0.470
34	1.172	17.023	0.667	0.681	12.149	0.667	0.681	12.149	0.544	0.547	5.309	0.495
35	1.199	17.585	0.706	0.705	12.521	0.706	0.705	12.521	0.572	0.564	5.369	0.520
36	1.237	17.834	0.711	0.730	12.895	0.711	0.730	12.895	0.576	0.582	5.562	0.524
37	1.275	18.084	0.716	0.754	13.269	0.716	0.754	13.269	0.580	0.601	5.755	0.527
38	1.313	18.333	0.721	0.779	13.643	0.721	0.779	13.643	0.584	0.619	5.948	0.531
39	1.351	18.582	0.727	0.803	14.018	0.727	0.803	14.018	0.588	0.637	6.142	0.535
40	1.389	18.832	0.732	0.828	14.392	0.732	0.828	14.392	0.592	0.656	6.335	0.539
41	1.459	19.867	0.796	0.854	15.098	0.796	0.854	15.098	0.636	0.681	6.890	0.578
42	1.529	20.902	0.861	0.880	15.805	0.861	0.880	15.805	0.681	0.707	7.445	0.617
43	1.599	21.937	0.925	0.907	16.511	0.925	0.907	16.511	0.726	0.732	7.999	0.657
44	1.669	22.972	0.989	0.933	17.217	0.989	0.933	17.217	0.771	0.758	8.554	0.696
45	1.738	24.008	1.053	0.959	17.924	1.053	0.959	17.924	0.815	0.783	9.109	0.735
46	1.784	24.572	1.096	0.989	18.458	1.096	0.989	18.458	0.840	0.799	9.593	0.760
47	1.830	25.136	1.138	1.019	18.992	1.138	1.019	18.992	0.866	0.816	10.076	0.785
48	1.876	25.701	1.180	1.050	19.526	1.180	1.050	19.526	0.891	0.832	10.560	0.810
49	1.922	26.265	1.223	1.080	20.060	1.223	1.080	20.060	0.916	0.848	11.044	0.835
50	1.968	26.830	1.265	1.110	20.594	1.265	1.110	20.594	0.941	0.864	11.527	0.860
51	2.020	27.642	1.294	1.146	21.719	1.294	1.146	21.719	0.978	0.891	12.038	0.893
52	2.072	28.454	1.324	1.182	22.845	1.324	1.182	22.845	1.016	0.917	12.549	0.926
53	2.124	29.266	1.353	1.218	23.970	1.353	1.218	23.970	1.053	0.943	13.059	0.959
54	2.176	30.079	1.382	1.254	25.095	1.382	1.254	25.095	1.090	0.969	13.570	0.992
55	2.228	30.891	1.411	1.290	26.221	1.411	1.290	26.221	1.128	0.995	14.081	1.026
56	2.265	31.485	1.449	1.310	26.449	1.449	1.310	26.449	1.160	1.015	14.438	1.051
57	2.302	32.078	1.486	1.330	26.677	1.486	1.330	26.677	1.192	1.035	14.796	1.077
58	2.340	32.672	1.523	1.350	26.905	1.523	1.350	26.905	1.224	1.055	15.154	1.103
59	2.377	33.266	1.560	1.370	27.133	1.560	1.370	27.133	1.256	1.075	15.512	1.129
60	2.415	33.860	1.597	1.390	27.361	1.597	1.390	27.361	1.288	1.095	15.870	1.155
61	2.451	34.487	1.611	1.405	27.372	1.611	1.405	27.372	1.301	1.109	16.268	1.166
62	2.487	35.113	1.625	1.420	27.383	1.625	1.420	27.383	1.313	1.124	16.667	1.177
63	2.523	35.740	1.639	1.434	27.393	1.639	1.434	27.393	1.326	1.138	17.066	1.188
64	2.559	36.367	1.653	1.449	27.404	1.653	1.449	27.404	1.338	1.153	17.465	1.200
65	2.595	36.994	1.667	1.464	27.415	1.667	1.464	27.415	1.351	1.167	17.863	1.211
66	2.639	37.728	1.699	1.497	28.054	1.699	1.497	28.054	1.366	1.182	18.249	1.230
67	2.683	38.462	1.732	1.530	28.694	1.732	1.530	28.694	1.382	1.196	18.635	1.250
68	2.728	39.197	1.765	1.563	29.333	1.765	1.563	29.333	1.397	1.211	19.020	1.269
69	2.772	39.931	1.797	1.596	29.972	1.797	1.596	29.972	1.412	1.225	19.406	1.289
70	2.817	40.666	1.830	1.629	30.612	1.830	1.629	30.612	1.427	1.239	19.792	1.308
71	2.859	41.083	1.854	1.650	31.097	1.854	1.650	31.097	1.443	1.255	19.906	1.321
72	2.901	41.500	1.878	1.672	31.583	1.878	1.672	31.583	1.459	1.271	20.020	1.334
73	2.943	41.918	1.902	1.694	32.068	1.902	1.694	32.068	1.475	1.287	20.134	1.347
74	2.985	42.335	1.925	1.715	32.554	1.925	1.715	32.554	1.491	1.303	20.248	1.361
75	3.027	42.753	1.949	1.737	33.039	1.949	1.737	33.039	1.507	1.318	20.362	1.374
76	3.061	43.705	1.977	1.760	33.193	1.977	1.760	33.193	1.528	1.331	20.782	1.391
77	3.096	44.657	2.005	1.782	33.347	2.005	1.782	33.347	1.550	1.344	21.202	1.409
78	3.130	45.609	2.033	1.805	33.501	2.033	1.805	33.501	1.571	1.357	21.623	1.426
79	3.165	46.562	2.061	1.828	33.655	2.061	1.828	33.655	1.593	1.370	22.043	1.444
80	3.200	47.514	2.089	1.851	33.809	2.089	1.851	33.809	1.615	1.382	22.463	1.461
81	3.237	47.873	2.111	1.872	34.035	2.111	1.872	34.035	1.623	1.407	22.571	1.475
82	3.275	48.233	2.132	1.894	34.261	2.132	1.894	34.261	1.632	1.431	22.678	1.489

83	3.313	48.592	2.154	1.915	34.488	2.154	1.915	34.488	1.640	1.455	22.786	1.503
84	3.351	48.952	2.175	1.937	34.714	2.175	1.937	34.714	1.648	1.480	22.894	1.517
85	3.389	49.311	2.197	1.958	34.941	2.197	1.958	34.941	1.657	1.504	23.001	1.531
86	3.432	49.503	2.200	1.973	35.115	2.200	1.973	35.115	1.659	1.531	23.112	1.531
87	3.475	49.694	2.203	1.988	35.289	2.203	1.988	35.289	1.661	1.558	23.223	1.532
88	3.518	49.886	2.206	2.002	35.463	2.206	2.002	35.463	1.663	1.586	23.334	1.533
89	3.562	50.077	2.209	2.017	35.637	2.209	2.017	35.637	1.665	1.613	23.445	1.533
90	3.605	50.269	2.212	2.032	35.811	2.212	2.032	35.811	1.667	1.640	23.556	1.534
91	3.645	50.447	2.213	2.044	35.968	2.213	2.044	35.968	1.668	1.654	23.558	1.534
92	3.686	50.626	2.214	2.056	36.125	2.214	2.056	36.125	1.669	1.668	23.560	1.534
93	3.727	50.805	2.215	2.068	36.282	2.215	2.068	36.282	1.671	1.682	23.562	1.535
94	3.767	50.984	2.216	2.081	36.440	2.216	2.081	36.440	1.672	1.696	23.564	1.535
95	3.808	51.162	2.217	2.093	36.597	2.217	2.093	36.597	1.674	1.710	23.567	1.535
96	3.853	51.779	2.227	2.111	36.968	2.227	2.111	36.968	1.680	1.727	23.924	1.547
97	3.898	52.395	2.236	2.129	37.339	2.236	2.129	37.339	1.686	1.744	24.282	1.558
98	3.943	53.012	2.245	2.147	37.710	2.245	2.147	37.710	1.692	1.762	24.639	1.570
99	3.988	53.628	2.254	2.165	38.081	2.254	2.165	38.081	1.698	1.779	24.997	1.581
100	4.033	54.245	2.263	2.183	38.453	2.263	2.183	38.453	1.704	1.796	25.355	1.593
101	4.081	55.131	2.342	2.221	40.429	2.342	2.221	40.429	1.779	1.819	25.871	1.636
102	4.128	56.016	2.420	2.258	42.405	2.420	2.258	42.405	1.854	1.842	26.387	1.678
103	4.175	56.902	2.498	2.295	44.382	2.498	2.295	44.382	1.928	1.865	26.903	1.721
104	4.223	57.788	2.576	2.333	46.358	2.576	2.333	46.358	2.003	1.887	27.419	1.764
105	4.270	58.674	2.654	2.370	48.335	2.654	2.370	48.335	2.078	1.910	27.935	1.807
106	4.300	59.222	2.740	2.404	49.060	2.740	2.404	49.060	2.132	1.936	28.221	1.864
107	4.331	59.771	2.826	2.437	49.785	2.826	2.437	49.785	2.187	1.962	28.506	1.921
108	4.361	60.319	2.912	2.471	50.511	2.912	2.471	50.511	2.241	1.988	28.792	1.978
109	4.391	60.868	2.998	2.504	51.236	2.998	2.504	51.236	2.296	2.014	29.077	2.035
110	4.421	61.416	3.084	2.538	51.962	3.084	2.538	51.962	2.350	2.040	29.363	2.092
111	4.449	61.935	3.101	2.560	52.113	3.101	2.560	52.113	2.365	2.057	29.405	2.107
112	4.476	62.455	3.118	2.582	52.265	3.118	2.582	52.265	2.381	2.074	29.447	2.121
113	4.503	62.974	3.136	2.604	52.417	3.136	2.604	52.417	2.396	2.090	29.489	2.135
114	4.531	63.493	3.153	2.625	52.569	3.153	2.625	52.569	2.411	2.107	29.531	2.149
115	4.558	64.013	3.170	2.647	52.721	3.170	2.647	52.721	2.426	2.124	29.573	2.163
116	4.600	64.559	3.173	2.673	52.723	3.173	2.673	52.723	2.430	2.152	29.865	2.166
117	4.642	65.105	3.175	2.698	52.724	3.175	2.698	52.724	2.433	2.179	30.157	2.169
118	4.684	65.651	3.178	2.723	52.726	3.178	2.723	52.726	2.437	2.207	30.449	2.173
119	4.726	66.197	3.181	2.749	52.728	3.181	2.749	52.728	2.441	2.234	30.741	2.176
120	4.768	66.743	3.184	2.774	52.729	3.184	2.774	52.729	2.445	2.262	31.033	2.179
121	4.804	67.600	3.206	2.799	53.168	3.206	2.799	53.168	2.467	2.276	31.230	2.200
122	4.840	68.458	3.229	2.824	53.606	3.229	2.824	53.606	2.489	2.290	31.428	2.222
123	4.876	69.315	3.251	2.850	54.044	3.251	2.850	54.044	2.512	2.304	31.625	2.243
124	4.911	70.173	3.274	2.875	54.483	3.274	2.875	54.483	2.534	2.318	31.823	2.265
125	4.947	71.030	3.296	2.900	54.921	3.296	2.900	54.921	2.557	2.332	32.020	2.286
126	4.983	71.729	3.310	2.920	55.078	3.310	2.920	55.078	2.569	2.355	32.099	2.297
127	5.019	72.427	3.323	2.941	55.236	3.323	2.941	55.236	2.580	2.377	32.178	2.307
128	5.055	73.126	3.337	2.961	55.393	3.337	2.961	55.393	2.592	2.399	32.256	2.318
129	5.091	73.825	3.350	2.981	55.551	3.350	2.981	55.551	2.604	2.422	32.335	2.329
130	5.126	74.523	3.364	3.001	55.708	3.364	3.001	55.708	2.616	2.444	32.413	2.339
131	5.178	75.331	3.370	3.027	55.921	3.370	3.027	55.921	2.619	2.464	32.638	2.343
132	5.230	76.139	3.376	3.052	56.134	3.376	3.052	56.134	2.623	2.485	32.862	2.347
133	5.282	76.947	3.382	3.078	56.346	3.382	3.078	56.346	2.627	2.505	33.086	2.350
134	5.334	77.755	3.388	3.103	56.559	3.388	3.103	56.559	2.630	2.525	33.310	2.354
135	5.386	78.563	3.394	3.129	56.771	3.394	3.129	56.771	2.634	2.545	33.534	2.358
136	5.468	79.372	3.432	3.167	57.854	3.432	3.167	57.854	2.672	2.573	34.147	2.395
137	5.549	80.181	3.469	3.206	58.937	3.469	3.206	58.937	2.711	2.600	34.760	2.431
138	5.630	80.990	3.507	3.244	60.020	3.507	3.244	60.020	2.749	2.628	35.373	2.468
139	5.712	81.798	3.544	3.283	61.102	3.544	3.283	61.102	2.787	2.655	35.985	2.505
140	5.793	82.607	3.582	3.322	62.185	3.582	3.322	62.185	2.826	2.682	36.598	2.542
141	5.825	83.486	3.639	3.342	62.366	3.639	3.342	62.366	2.851	2.702	36.880	2.574
142	5.856	84.365	3.697	3.363	62.548	3.697	3.363	62.548	2.875	2.722	37.162	2.606
143	5.888	85.245	3.754	3.383	62.729	3.754	3.383	62.729	2.900	2.742	37.444	2.638

144	5.920	86.124	3.811	3.404	62.910	3.811	3.404	62.910	2.925	2.762	37.727	2.671
145	5.951	87.003	3.869	3.425	63.091	3.869	3.425	63.091	2.949	2.782	38.009	2.703
146	5.975	87.915	3.892	3.453	63.539	3.892	3.453	63.539	2.959	2.797	38.632	2.715
147	5.998	88.827	3.916	3.482	63.987	3.916	3.482	63.987	2.968	2.811	39.255	2.726
148	6.022	89.739	3.939	3.510	64.435	3.939	3.510	64.435	2.978	2.825	39.878	2.738
149	6.046	90.652	3.963	3.539	64.883	3.963	3.539	64.883	2.987	2.839	40.501	2.750
150	6.069	91.564	3.986	3.568	65.331	3.986	3.568	65.331	2.997	2.853	41.124	2.762
151	6.099	92.475	4.000	3.595	65.704	4.000	3.595	65.704	3.007	2.868	41.450	2.774
152	6.129	93.387	4.014	3.623	66.077	4.014	3.623	66.077	3.017	2.883	41.776	2.786
153	6.159	94.298	4.029	3.650	66.450	4.029	3.650	66.450	3.028	2.898	42.102	2.799
154	6.189	95.209	4.043	3.677	66.823	4.043	3.677	66.823	3.038	2.913	42.428	2.811
155	6.219	96.121	4.057	3.705	67.197	4.057	3.705	67.197	3.049	2.927	42.754	2.823
156	6.313	97.599	4.117	3.767	69.206	4.117	3.767	69.206	3.113	2.969	44.233	2.870
157	6.407	99.077	4.176	3.829	71.215	4.176	3.829	71.215	3.178	3.011	45.712	2.917
158	6.501	100.555	4.236	3.891	73.225	4.236	3.891	73.225	3.242	3.053	47.191	2.964
159	6.595	102.033	4.295	3.953	75.234	4.295	3.953	75.234	3.307	3.095	48.670	3.011
160	6.689	103.511	4.355	4.015	77.243	4.355	4.015	77.243	3.371	3.136	50.149	3.057
161	7.010	107.552	4.551	4.078	79.985	4.551	4.078	79.985	3.503	3.182	51.569	3.181
162	7.331	111.593	4.747	4.142	82.727	4.747	4.142	82.727	3.635	3.227	52.988	3.306
163	7.652	115.634	4.943	4.205	85.469	4.943	4.205	85.469	3.767	3.272	54.408	3.430
164	7.972	119.676	5.139	4.268	88.211	5.139	4.268	88.211	3.899	3.318	55.828	3.554
165	8.293	123.717	5.335	4.332	90.953	5.335	4.332	90.953	4.030	3.363	57.247	3.678
166	8.671	125.252	5.516	4.380	93.266	5.516	4.380	93.266	4.145	3.410	58.958	3.796
167	9.050	126.786	5.696	4.428	95.579	5.696	4.428	95.579	4.260	3.458	60.670	3.914
168	9.428	128.321	5.876	4.477	97.892	5.876	4.477	97.892	4.375	3.505	62.381	4.033
169	9.806	129.855	6.056	4.525	100.205	6.056	4.525	100.205	4.490	3.552	64.092	4.151
170	10.184	131.390	6.237	4.573	102.517	6.237	4.573	102.517	4.605	3.600	65.804	4.269
171	10.426	132.095	6.345	4.618	103.813	6.345	4.618	103.813	4.673	3.644	66.939	4.322
172	10.667	132.801	6.452	4.664	105.109	6.452	4.664	105.109	4.741	3.688	68.075	4.374
173	10.909	133.506	6.560	4.709	106.404	6.560	4.709	106.404	4.808	3.732	69.210	4.426
174	11.150	134.211	6.668	4.754	107.700	6.668	4.754	107.700	4.876	3.776	70.345	4.479
175	11.392	134.917	6.776	4.799	108.995	6.776	4.799	108.995	4.944	3.821	71.481	4.531
176	11.439	137.703	6.910	4.858	110.733	6.910	4.858	110.733	5.057	3.856	73.077	4.626
177	11.486	140.490	7.045	4.917	112.471	7.045	4.917	112.471	5.171	3.891	74.674	4.722
178	11.533	143.276	7.179	4.977	114.209	7.179	4.977	114.209	5.284	3.927	76.271	4.817
179	11.581	146.063	7.313	5.036	115.946	7.313	5.036	115.946	5.398	3.962	77.867	4.912
180	11.628	148.849	7.447	5.095	117.684	7.447	5.095	117.684	5.511	3.997	79.464	5.008
181	11.671	154.282	7.621	5.158	119.775	7.621	5.158	119.775	5.641	4.024	81.282	5.111
182	11.715	159.715	7.795	5.221	121.866	7.795	5.221	121.866	5.770	4.050	83.100	5.214
183	11.759	165.147	7.969	5.284	123.956	7.969	5.284	123.956	5.900	4.077	84.919	5.318
184	11.803	170.580	8.143	5.347	126.047	8.143	5.347	126.047	6.029	4.104	86.737	5.421
185	11.846	176.013	8.318	5.411	128.138	8.318	5.411	128.138	6.159	4.131	88.555	5.524
186	11.887	179.970	8.499	5.428	129.673	8.499	5.428	129.673	6.285	4.154	90.333	5.656
187	11.928	183.927	8.681	5.446	131.209	8.681	5.446	131.209	6.411	4.178	92.110	5.787
188	11.969	187.884	8.862	5.463	132.745	8.862	5.463	132.745	6.537	4.202	93.888	5.919
189	12.010	191.841	9.043	5.481	134.281	9.043	5.481	134.281	6.663	4.225	95.665	6.050
190	12.051	195.798	9.225	5.499	135.816	9.225	5.499	135.816	6.789	4.249	97.442	6.182
191	12.090	197.691	9.386	5.561	137.198	9.386	5.561	137.198	6.875	4.285	98.856	6.266
192	12.128	199.584	9.547	5.623	138.580	9.547	5.623	138.580	6.961	4.321	100.271	6.350
193	12.166	201.476	9.708	5.686	139.961	9.708	5.686	139.961	7.047	4.357	101.685	6.435
194	12.205	203.369	9.869	5.748	141.343	9.869	5.748	141.343	7.133	4.393	103.099	6.519
195	12.243	205.262	10.030	5.810	142.724	10.030	5.810	142.724	7.219	4.430	104.513	6.603
196	12.281	208.341	10.188	5.828	144.052	10.188	5.828	144.052	7.346	4.460	106.134	6.706
197	12.319	211.419	10.346	5.845	145.381	10.346	5.845	145.381	7.473	4.490	107.755	6.810
198	12.357	214.498	10.504	5.863	146.709	10.504	5.863	146.709	7.600	4.520	109.376	6.913
199	12.395	217.577	10.662	5.880	148.037	10.662	5.880	148.037	7.727	4.550	110.997	7.017
200	12.433	220.656	10.820	5.898	149.365	10.820	5.898	149.365	7.853	4.580	112.617	7.120
201	12.509	221.810	10.948	5.942	150.214	10.948	5.942	150.214	7.929	4.623	113.207	7.195
202	12.585	222.965	11.075	5.986	151.063	11.075	5.986	151.063	8.005	4.666	113.796	7.270
203	12.661	224.119	11.203	6.029	151.912	11.203	6.029	151.912	8.080	4.709	114.385	7.345
204	12.738	225.274	11.330	6.073	152.760	11.330	6.073	152.760	8.156	4.752	114.974	7.419

205	12.814	226.429	11.458	6.117	153.609	11.458	6.117	153.609	8.232	4.795	115.563	7.494
206	12.891	228.364	11.530	6.174	154.888	11.530	6.174	154.888	8.295	4.848	116.847	7.544
207	12.969	230.299	11.601	6.231	156.166	11.601	6.231	156.166	8.357	4.901	118.131	7.594
208	13.046	232.235	11.673	6.288	157.445	11.673	6.288	157.445	8.420	4.955	119.415	7.644
209	13.124	234.170	11.745	6.345	158.724	11.745	6.345	158.724	8.483	5.008	120.699	7.694
210	13.201	236.105	11.817	6.401	160.002	11.817	6.401	160.002	8.545	5.061	121.983	7.744
211	13.233	239.385	11.984	6.451	161.606	11.984	6.451	161.606	8.670	5.090	123.498	7.846
212	13.264	242.664	12.152	6.500	163.210	12.152	6.500	163.210	8.794	5.119	125.012	7.948
213	13.296	245.943	12.319	6.550	164.814	12.319	6.550	164.814	8.919	5.147	126.526	8.051
214	13.328	249.223	12.486	6.599	166.418	12.486	6.599	166.418	9.043	5.176	128.040	8.153
215	13.359	252.502	12.653	6.649	168.022	12.653	6.649	168.022	9.168	5.204	129.554	8.255
216	13.423	253.243	12.780	6.693	168.948	12.780	6.693	168.948	9.251	5.240	130.345	8.328
217	13.487	253.983	12.906	6.737	169.874	12.906	6.737	169.874	9.334	5.275	131.136	8.400
218	13.551	254.724	13.032	6.782	170.800	13.032	6.782	170.800	9.417	5.310	131.928	8.472
219	13.615	255.464	13.159	6.826	171.726	13.159	6.826	171.726	9.500	5.345	132.719	8.545
220	13.679	256.204	13.285	6.870	172.653	13.285	6.870	172.653	9.584	5.380	133.510	8.617
221	13.852	256.417	13.314	6.946	173.200	13.314	6.946	173.200	9.598	5.436	133.899	8.630
222	14.025	256.629	13.343	7.022	173.748	13.343	7.022	173.748	9.612	5.492	134.287	8.642
223	14.198	256.841	13.371	7.098	174.295	13.371	7.098	174.295	9.627	5.548	134.676	8.655
224	14.371	257.053	13.400	7.173	174.843	13.400	7.173	174.843	9.641	5.604	135.064	8.667
225	14.544	257.265	13.429	7.249	175.391	13.429	7.249	175.391	9.655	5.660	135.453	8.680
226	14.737	257.645	13.440	7.334	175.611	13.440	7.334	175.611	9.664	5.699	135.633	8.688
227	14.929	258.025	13.452	7.419	175.831	13.452	7.419	175.831	9.674	5.738	135.814	8.696
228	15.122	258.405	13.464	7.504	176.051	13.464	7.504	176.051	9.683	5.776	135.995	8.704
229	15.315	258.785	13.475	7.589	176.271	13.475	7.589	176.271	9.692	5.815	136.176	8.712
230	15.507	259.165	13.487	7.674	176.491	13.487	7.674	176.491	9.701	5.854	136.356	8.720
231	15.616	259.629	13.498	7.710	176.612	13.498	7.710	176.612	9.710	5.875	136.581	8.727
232	15.725	260.092	13.508	7.746	176.732	13.508	7.746	176.732	9.719	5.897	136.806	8.733
233	15.834	260.556	13.519	7.782	176.853	13.519	7.782	176.853	9.728	5.918	137.031	8.740
234	15.944	261.020	13.530	7.818	176.974	13.530	7.818	176.974	9.737	5.940	137.256	8.746
235	16.053	261.484	13.540	7.853	177.095	13.540	7.853	177.095	9.746	5.961	137.482	8.753
236	16.085	261.890	13.551	7.867	177.463	13.551	7.867	177.463	9.754	5.977	137.680	8.760
237	16.117	262.296	13.561	7.881	177.830	13.561	7.881	177.830	9.761	5.994	137.879	8.767
238	16.149	262.701	13.572	7.894	178.198	13.572	7.894	178.198	9.769	6.010	138.078	8.774
239	16.181	263.107	13.582	7.908	178.566	13.582	7.908	178.566	9.777	6.026	138.277	8.781
240	16.214	263.513	13.592	7.922	178.933	13.592	7.922	178.933	9.785	6.042	138.476	8.788