United States
Environmental Protection Agency

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April 1994

Air

High-Tech I/M Test Procedures, Emission Standards, Quality Control Requirements, and Equipment Specifications

Final

Technical Guidance

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Introduction

This document is the successor to the July version of "High-Tech I/M Test Procedures, Emission Standards, Quality Control Requirements, and Equipment Specifications," and you should replace your old copy of the Technical Guidance with this one once you have noted the changes. There are relatively few changes and many of them are more in the nature of clarifications than substantive changes. However, some changes were necessary due to information that came to light as some states and contractors began the process of finalizing detailed specifications and plans for their testing networks and implementing the new tests.

The IM240 test equipment specifications have not been changed. Some clarifications were added to the fast-pass/fast-fail logic in §85.2205(a)(4) and §85.2205(c)(2); however, the logic is the same as described in the EPA memorandum of October 13, 1993. The Speed Variation Limits in §85.2221 were found to produce a high void test rate when applied to tests that ended before 240 seconds using the fast-pass and fast-fail algorithms. The previously published limits apply only to tests lasting the full 240 seconds. EPA is developing limits for tests that end earlier. The provision for augmented braking in §85.2226(a)(5)(v) has been changed to require fully automatic augmented braking on the two major decelerations of the test and to allow it elsewhere. This was done to reduce the number of test voids that would otherwise occur due to speed excursions in these portions of the test. The purge meter specifications in §85.2227 have been revised to better ensure the desired accuracy in the lower end of the range, which is most important for pass/fail decisions. In addition, some revisions and clarifications have been made to §85.3334, on quality control for IM240 test equipment.

The test procedures and related requirements are presented in this document in the language and format in which EPA intends to propose to promulgate them in the Code of Federal Regulations under §207(b) of the Clean Air Act as official I/M tests. We project that we will publish a Notice of Proposed Rulemaking in July of this year. No additional revisions will be made prior to proposal. Interested parties will, of course, have the opportunity to comment on these provisions when they are proposed. However, EPA believes that minimal changes, if any, will be made in the rule making process, given that the test procedures and related requirements, as presented here, already reflect an understanding of the views of the primary interested parties.

Because the coverage, language, and format of the test procedures and related requirements are specific to EPA's plan to propose the high tech tests as 207(b) tests, state agencies will want to extract and reformat those portions relevant to their own needs. A state specifying equipment for state-operated inspection stations, for example, would not need to copy all the same parts as a state preparing a request for proposals for construction and operation of stations. Also references to "the Administrator" will need to be changed.

Section 85.2205(a), "IM240 Emission Standards," requires special explanation. In §85.2205(a)(2), EPA has listed start-up standards which it currently recommends be adopted for inspections performed in 1995 and 1996. More stringent final standards for 1997 and later are recommended in §85.2205(a)(3). EPA recommends the looser start-up standards for the first two years of a high-tech I/M program primarily out of concern for the transitional capability of the vehicle repair industry to handle the number of failed cars. By 1997, repair facilities will be more adept, more may have entered the I/M repair business, and much of the accumulated backlog of defective vehicles will have already been repaired, allowing the IM240 standards to be tightened for greater emission reduction. EPA advises states to retain as much flexibility to revise inspection standards during 1995 and 1996 as possible, since local experience may indicate the advisability of either more or less stringent start-up standards than shown in §85.2205(a)(3). In its Federal Register proposal to establish 207(b) tests, EPA intends to propose the standards shown in §85.2205(a)(3) for use even in 1995 and 1996, since EPA does not doubt that they satisfy the requirements for a 207(b) test. However; EPA will be monitoring the situation closely as states begin testing in 1995 and to ensure that the recommended standards in this document are producing the desired outcome and is prepared to revisit and revise these standards if significant unanticipated problems develop.

Some readers have noted that this Technical Guidance document does not contain standards and procedures for the evaporative integrity, or "pressure" test. EPA has previously published the test procedure and standards in the I/M regulation, in §51.357(a)(10) and (b)(3)(i). Requirements related to the evaporative system integrity test will, of course, be included in the 207(b) rule making.

§85.2205 Short Test Standards - IM240-Purge Test

(a) IM240 Emission Standards

(1) Two Ways to Pass Standards. If the corrected, composite emission rates calculated in paragraph (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 calendar years 1995 and 1996. Tier 1 standards are recommended for 1996 and later vehicles and may be used for 1994 and later 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	*(Reserved)*
1991-1995	1.20	0.75	20.0	16.0	2.5	*(Reserved)*
1983-1990	2.00	1.25	30.0	24.0	3.0	*(Reserved)*
1981-1982	2.00	1.25	60.0	48.0	3.0	*(Reserved)*
1980	2.00	1.25	60.0	48.0	6.0	*(Reserved)*
1977-1979	7.50	5.00	90.0	72.0	6.0	*(Reserved)*
1975-1976	7.50	5.00	90.0	72.0	9.0	*(Reserved)*
1973-1974	10.0	6.00	150	120	9.0	*(Reserved)*
1968-1972	10.0	6.00	150	120	10.0	*(Reserved)*

(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	*(Reserved)*
1982	2.00	1.25	75.0	60.0	3.0	*(Reserved)*

(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	(Reserved)
(>3750 LVW)	1.00	0.63	20.0	16.0	2.5	*(Reserved)*
1991-1995	2.40	1.50	60.0	48.0	3.0	*(Reserved)*
1988-1990	3.20	2.00	80.0	64.0	3.5	*(Reserved)*
1984-1987	3.20	2.00	80.0	64.0	7.0	*(Reserved)*
1979-1983	7.50	5.00	100	80.0	7.0	*(Reserved)*
1975-1978	8.00	5.00	120	96.0	9.0	*(Reserved)*
1973-1974	10.0	6.00	150	120	9.0	*(Reserved)*

1968-1972	10.0	6.00	150	120	10.0	(*Reserved*)

(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	(*Reserved*)
1988-1990	4.00	2.50	90.0	72.0	3.5	(*Reserved*)
1984-1987	4.00	2.50	90.0	72.0	7.0	(*Reserved*)
1982-1983	8.00	5.00	130	104	7.0	(*Reserved*)

(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	(*Reserved*)
(>5750 LVW)	2.40	1.50	60.0	48.0	4.0	(*Reserved*)
1991-1995	2.40	1.50	60.0	48.0	4.5	(*Reserved*)
1988-1990	3.20	2.00	80.0	64.0	5.0	(*Reserved*)
1984-1987	3.20	2.00	80.0	64.0	7.0	(*Reserved*)
1979-1983	7.50	5.00	100	80.0	7.0	(*Reserved*)
1975-1978	8.00	5.00	120	96.0	9.0	(*Reserved*)
1973-1974	10.0	6.00	150	120	9.0	(*Reserved*)
1968-1972	10.0	6.00	150	120	10.0	(*Reserved*)

(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	(*Reserved*)
1988-1990	4.00	2.50	90.0	72.0	5.0	(*Reserved*)
1984-1987	4.00	2.50	90.0	72.0	7.0	(*Reserved*)
1982-1983	8.00	5.00	130	104	7.0	(*Reserved*)

(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	(*Reserved*)
1983-1995	0.80	0.50	15.0	12.0	2.0	(*Reserved*)
1981-1982	0.80	0.50	30.0	24.0	2.0	(*Reserved*)
1980	0.80	0.50	30.0	24.0	4.0	(*Reserved*)
1977-1979	3.00	2.00	65.0	52.0	4.0	(*Reserved*)
1975-1976	3.00	2.00	65.0	52.0	6.0	(*Reserved*)
1973-1974	7.00	4.50	120	96.0	6.0	(*Reserved*)
1968-1972	7.00	4.50	120	96.0	7.0	(*Reserved*)

(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	(*Reserved*)
1982	1.20	0.75	45.0	36.0	2.0	(*Reserved*)

(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	(*Reserved*)
(>3750 LVW)	0.80	0.50	13.0	10.0	1.8	(*Reserved*)
1988-1995	1.60	1.00	40.0	32.0	2.5	(*Reserved*)
1984-1987	1.60	1.00	40.0	32.0	4.5	(*Reserved*)
1979-1983	3.40	2.00	70.0	56.0	4.5	(*Reserved*)
1975-1978	4.00	2.50	80.0	64.0	6.0	(*Reserved*)
1973-1974	7.00	4.50	120	96.0	6.0	(*Reserved*)
1968-1972	7.00	4.50	120	96.0	7.0	(*Reserved*)

(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
1988+	2.00	1.25	60.0	48.0	2.5	(*Reserved*)
1984-1987	2.00	1.25	60.0	48.0	4.5	(*Reserved*)
1982-1983	4.00	2.50	90.0	72.0	4.5	(*Reserved*)

(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)	0.80	0.50	13.0	10.0	1.8	(*Reserved*)
(>5750 LVW)	0.80	0.50	15.0	12.0	2.0	(*Reserved*)
1988-1995	1.60	1.00	40.0	32.0	3.5	(*Reserved*)
1984-1987	1.60	1.00	40.0	32.0	4.5	(*Reserved*)
1979-1983	3.40	2.00	70.0	56.0	4.5	(*Reserved*)
1975-1978	4.00	2.50	80.0	64.0	6.0	(*Reserved*)
1973-1974	7.00	4.50	120	96.0	6.0	(*Reserved*)
1968-1972	7.00	4.50	120	96.0	7.0	(*Reserved*)

(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
1988+	2.00	1.25	60.0	48.0	3.5	(*Reserved*)
1984-1987	2.00	1.25	60.0	48.0	4.5	(*Reserved*)
1982-1983	4.00	2.50	90.0	72.0	4.5	(*Reserved*)

(4) Fast-Pass and Fast-Fail. Vehicles may be fast-passed and/or fast-failed using the following algorithm.

(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-fail or 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 94 forward in grams shall be compared to cumulative second-by-second fast-fail or fast-pass Phase 2 emission standards for the second under consideration.

(ii) A vehicle shall pass the IM240 test 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) Optionally, a vehicle shall fail the IM240 test 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 above the full cycle fast-fail standard for the second under consideration; or,

(B) at second 94 and later, for exhaust components subject to Phase 2 standards, the following two conditions must be satisfied simultaneously:

(i) cumulative full cycle emissions for the second under consideration are above the minimum cumulative composite emission level for vehicles failing the test, and

(ii) cumulative Phase 2 emissions are above the Phase 2 fast-fail standard for the second under consideration.

(iv) Testing may be terminated when fast-pass or fast-fail criteria are met for all subject exhaust components and for purge as described in paragraph (c)(1), (c)(3)(ii), or (c)(3)(iii) of this section in the same second.

(v) If a fast-pass or fast-fail 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 paragraph (a)(1) of this section.

(vi) In instances where the fast-pass and fast-fail standards converge at some point in the driving cycle, if the vehicle has not either fast-passed or fast-failed at the point where the standards converge, it may fast-pass if it falls below the fast-pass standard in the next second. Otherwise the test shall continue for the duration of the full driving cycle.

(b) Transient Test Score Calculations

(1) Composite Scores. The composite scores for the test or test mode shall be determined by dividing the sum of the mass of each exhaust component obtained in each second of the test or mode by the number of miles driven in the test or test mode. The first data point is the sample taken from t=0 to t=1. The IM240 shall be divided into four modes as follows:

Mode	Cycle Portion
1	0-60 seconds
2	61-119 seconds
3	120-174 seconds
4	175-239 seconds

The composite test score shall be obtained by weighting the modes by their weighting factors, if applicable, and averaging them. The composite test value shall be calculated by the equation in (b)(1)(i):

(i) 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 / fast fail
= 239 seconds for complete IM240

(ii) Where the composite emissions are to be calculated by weighting factors, the equation in (b)(1)(iii) shall be used

(iii)

$$gpm_c = WF1 * \left[\frac{\sum_{sec=0}^{s1} grams_e}{\sum_{sec=0}^{s1} miles} \right] + WF2 * \left[\frac{\sum_{sec=s1+1}^{s2} grams_e}{\sum_{sec=s1+1}^{s2} miles} \right] + WF3 * \left[\frac{\sum_{sec=s2+1}^{s3} grams_e}{\sum_{sec=s2+1}^{s3} miles} \right] + WF4 * \left[\frac{\sum_{sec=s3+1}^{s4} grams_e}{\sum_{sec=s3+1}^{s4} miles} \right]$$

Where:
$grams_e$ = grams of emissions (HC, CO, and NOx)
gpm_c = composite grams per mile
miles = miles traveled
s1 = 60 second, or duration of test for fast pass / fast fail
s2 = 119 second, or duration of test for fast pass / fast fail
s3 = 174 second, or duration of test for fast pass / fast fail
s4 = 239 second, or duration of test for fast pass / fast fail
WF1 = weighting factor for mode 1 = *(Reserved)*
WF2 = weighting factor for mode 2 = *(Reserved)*
WF3 = weighting factor for mode 3 = *(Reserved)*
WF4 = weighting factor for mode 4 = *(Reserved)*

(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: $HC_{mass} = V_{mix}*Density_{HC}*(HC_{conc}/1,000,000)$

(ii) Carbon Monoxide mass: $CO_{mass} = V_{mix}*Density_{CO}*(CO_{conc}/1,000,000)$

(iii) Oxides of Nitrogen mass:
$NO_{xmass} = V_{mix}*Density_{NO2}*K_H*(NO_{xconc}/1,000,000)$

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

(3) Meaning of Symbols.

(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) $HC_{conc} = HC_e-HC_d(1-1/DF)$. 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 = $13.4 / [CO2_e+(HC_e+CO_e)*10-4]$, 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 described in §85.2226(c)(4), and corrected for background, water vapor, and CO_2 extraction, in ppm.

(A) $CO_{conc} = CO_e-CO_d(1-1/DF)$

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

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(D) 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) $NOx_{conc} = NOx_e - NOx_d(1-1/DF)$

(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), as measured in ppm.

(xi) K_H= humidity correction factor.

(A) $K_H = 1/[1-0.0047(H-75)]$.

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

(C) $H = [(43.478)R_a*P_d]/[P_B-(P_d*R_a/100)]$

(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)(4), and corrected for background in percent.

(A) $CO2_{conc} = CO_{2e} - CO_{2d}(1-1/DF)$

(B) CO2d = Background carbon dioxide concentration of the dilution air, sampled as described in §85.2221(b)(5), as measured in percent.

(c) 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(a)(2)(vi) shall not be included in the total flow calculation.

(2) Total Flow Method Fast-Pass and Fast-Fail. Vehicles may be fast-passed and/or fast-failed 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 and fast-fail 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) A vehicle shall fail the purge test if cumulative purge levels are below the fast-fail standard for the second under consideration;

(iv) Testing may be terminated when a fast-pass or fast-fail decision has been made for purge and for all subject exhaust components in the IM240 as described in paragraph (a)(4)(ii), (a)(4)(iii) or (a)(4)(v) of this section.

(v) If a fast-pass or fast-fail 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 purge levels over the full driving cycle as described in paragraph (c)(1) of this section.

(3) Flow Rate Method. *(Reserved)*

§85.2221 IM240 and Purge Test Procedure

(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) Gross vehicle weight rating, and
(vi) Number of cylinders, or cubic inch displacement of the engine.

(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, or 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 sidewall pressure, or manufacturers recommendation. Tires of vehicles being tested for the purposes of program evaluation under §51.353(c) shall have their tires inflated to tire sidewall 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 paragraph (f)(3) of this section. 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, 35 ppm CO, and 2 ppm NOx.

(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 or rejection from testing (rejection shall be counted as failure for purposes of reporting to EPA).

(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 or shall be rejected from testing. All hoses disconnected for the test shall be reconnected after a purge flow test is performed.

(iii) The purge flow measurement equipment shall be pneumatically connected in series between the evaporative canister and the engine, preferably on the canister end of the hose.

(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 positione and activated. 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:

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VEHICLE TYPE	NUMBER OF CYLINDERS	ACTUAL ROAD LOAD HORSEPOWER	TEST INERTIA WEIGHT
All	3	8.3	2000
All	4	9.4	2500
All	5	10.3	3000
All	6	10.3	3000
LDGV	8	11.2	3500
LDGT	8	12.0	4000
LDGV	10	11.2	3500
LDGT	10	12.7	4500
LDGV	12	12.0	4000
LDGT	12	13.4	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 when the standards specified in §51.351(a)(7) apply.

(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 (e)(1) of this section.

(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 paragraph (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 (i) through (iii) of this paragraph 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 paragraph (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 or rejection from testing.

(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 be 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)(4).

(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(a).

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

§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 allowed upon a determination by the Administrator that, for the propose 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. In the absence of new car certification coefficients or a vehicle class designator, the following track coefficients in paragraphs (a)(2)(i)(A) through (a)(2)(i)(C) of this section shall be used.

(A) $A_V = (0.35 / 50) * (\text{TRLHP@ 50 mph})$ hp/mph

(B) $B_V = (0.10 / 2500) * (\text{TRLHP@ 50 mph})$ hp/mph2

(C) $C_V = (0.55 / 125{,}000) * (\text{TRLHP@ 50 mph})$ hp/mph^3

(ii) Vehicle Loading. The true vehicle loading used during the transient driving cycle shall follow the equation in paragraph (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 paragraph (a)(2)(iv) or pre-defined horsepower values may be used.

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

Av, Bv, Cv = Coefficients specified in paragraph (a)(2)(i) of this section for vehicle track coast down curves.

Obmph = Observed mph

TRLHP = Track Road-Load Horsepower
= Which, on a dynamometer, includes loading contributions from the power absorber, parasitic losses, and tire/roll interface losses.

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

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 paragraph (a)(2)(vi) may be used to convert track road-load horsepower values in paragraph (a)(2)(iii) to units of force.

(vi) $TRLF_{@\ Obmph} = \{A_f * Obmph\} + \{B_f * Obmph^2\} + \{C_f * Obmph^3\}$

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)

Af, Bf, Cf = Equivalent force coefficients to the coefficients specified in paragraph (a)(2)(i) of this section 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 6 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 6 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 paragraph (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 paragraph (a)(2)(xi) when the dynamometer is set for a 2000 pound vehicle with a track road-load horsepower of 6 horsepower at 50 mph.

(xi) $$ET = \frac{ETW * (V_{12}^2 - V_8^2)}{21.94 * (A_{f4} + B_{f4}V + C_{f4}V^2)}$$

V_{12} = 12 mph

V_8 = 8 mph

V = 10 mph

A_{f4} = 375 * A_{d4} (A_{d4} in HP/mph units)

B_{f4} = 375 * B_{d4} (B_{d4} in HP/mph^2 units)

C_{f4} = 375 * C_{d4} (C_{d4} in HP/mph^3 units)

A_{f4}, B_{f4}, and C_{f4} are dynamometer road-load curve coefficients in "force" units which include parasitic losses and power absorber loading.

A_{d4}, B_{d4}, and C_{d4} are the dynamometer road-load curve coefficients necessary to properly load a vehicle with a 50 mph track road-load horsepower (TRLHP) of 6 horsepower. Note, tire/roll interface losses are not included in these dynamometer coefficients.

(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 (a)(2)(xiii) may be used to quantify tire/roll interface losses. In the absence of new car certification coefficients or a vehicle class designator, the curve coefficients in paragraphs (a)(2)(xiii)(A) through (a)(2)(xiii)(J) of this section shall be used.

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

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$GTRL_{@\ Obmph}$ = 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	=	(0.xx / 50)	*	(GTRL@ 50 mph)	hp/mph
(B)	B_t	=	(0.yy / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(C)	C_t	=	(0.zz / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3
(D)	A_{t8}	=	(0.pp/ 50)	*	(GTRL@ 50 mph)	hp/mph
(E)	B_{t8}	=	(0.qq / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(F)	C_{t8}	=	(0.rr / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3
(G)	A_{t20}	=	(0.tt / 50)	*	(GTRL@ 50 mph)	hp/mph
(H)	B_{t20}	=	(0.uu / 2500)	*	(GTRL@ 50 mph)	hp/mph2
(I)	C_{t20}	=	(0.vv / 125,000)	*	(GTRL@ 50 mph)	hp/mph^3

(J) Where:

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

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

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

(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 (a)(2)(xv) of this section when using twin 8.625 inch diameter rolls

(B) by the equation in (a)(2)(xvi) of this section when using twin 20.0 inch diameter rolls

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

Where:

DAXWT = Axle weight on the drive tires

GTRL@ 50 mph = Losses for 20.0 inch diameter roll

(xiv) Indicated Horsepower. The power absorption for each test shall be s d 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 paragraph (a)(2)(xv).

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

(xvi) 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 paragraph (a)(2)(xvii). Approximations for a smooth curve with no discontinuities may be used between 0 and 10 mph.

(xvii) $IHP_{@\ 0bmph} = TRLHP_{@\ 0bmph} - PLHP_{@\ 0bmph} - GTRL_{@\ 0bmph}$

(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 paragraph (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 paragraphs (a)(2)(viii), (a)(2)(ix), and (a)(2)(xii) of this section as necessary to properly load vehicles as define in paragraphs (a)(2)(ii) and (a)(2)(iii) of this section. 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.

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(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) $ISE = (IW_S - I_t) / (IW_S)$

(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 TRLHP at the measure 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 paragraph(a)(2) of this section 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 propose 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 continuously 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 propose 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 Section 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) 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) Totalized 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 adaptors 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.

(5) Alternative Systems. Alternative purge flow equipment, specifications, materials, or designs, may be allowed upon a determination by the Administrator, that for the propose of properly conducting an approved short test, the evidence supporting such deviations will not appreciably or adversely affect the proper measurement of purge or the proper operation of the vehicle.

(b) Evaporative System Integrity Analysis System

(1) General Requirements. Pressure gauges or measurement devices used for this test shall have an accuracy of ±0.3 inches of water (2% of 15) or better. Nitrogen (N_2), or an equivalent non-toxic, non-greenhouse, inert gas, shall be used for pressurizing the evaporative system. Air may be used to pressurize the system if the state program administrator determines that potential flammability hazards are addressed and that N2 shall be used instead whenever temperature and pressure (and other conditions as needed) indicate a potential for explosion.

(2) 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 integrity 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.

(3) Adaptability. The system shall have sufficient adaptors to connect in a leak-tight manner with the variety of evaporative systems and hose deterioration conditions in the vehicle fleet.

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

(5) Alternative Systems. Alternative equipment, specifications, materials, or designs, may be allowed upon a determination by the Administrator that, for the propose of properly conducting an approved short test, the evidence supporting such deviations will not appreciably or adversely affect the proper determination of system integrity or the proper operation of the vehicle.

§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 paragraph (2) of this section. 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 propose 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.

(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, 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 greater than ±7% , or is out side of the time window calculated by §85.2234(b)(1)(iii)(A) and (B). 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 greater than ±10%, or is out side of the time window calculated by §85.2234(b)(1)(iii)(A) and (B) for the 22 mph to the 18 mph coast-down, official testing shall automatically be prevented, and corrective action shall be taken to bring the dynamometer into calibration.

(A) $$DT_{min} = \frac{IW * DelV}{(A + BV + CV2 + 3.3\ lbs) * 21.937}$$

(B) $$DT_{max} = \frac{IW * DelV}{(A + BV + CV2 - 3.3\ lbs) * 21.937}$$

(C) Where:

DT_{min}	=	Lower coast down limit (sec)
DT_{max}	=	Upper coast down limit (sec)
IW	=	Inertia weight selected (lb)
DelV	=	Width of coast down interval (mph)
V	=	Midpoint speed of coast down interval (mph)
±3.3	=	Allowable error in terms of force (pounds-force) equivalent to ±0.25 HP
A, B, C	=	Dynamometer setting coefficients needed to set the horsepower settings required in §85.2234(b)(1)(ii) and the inertia weight selected (if electrically simulated). For this calculation, these coeficients are those that represent TRLHP minus GTRL, or IHP plus PLHP. The coefficients used to adjust the dynamometer for coast-down test are those needed to set the dynamometer for the IHP corresponding to the horsepower settings required in §85.2234(b)(1)(ii).

(iv) The clock used to check the coast-down time shall be accurate to the nearest 0.01 seconds when summing 1000 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 paragraphs (b)(4)(i) through (b)(4)(v) of this section.

(i) Coast Down / Vehicle Loading Check. 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 in paragraphs (b)(4)(i)(A) through (b)(4)(i)(L) of this section, 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 preselected in paragraph (b)(4)(i)(B) in this section.

(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 paragraph (b)(4)(i)(C) of this section.

(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 paragraph (b)(4)(i)(E) of this section.

(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 paragraph (b)(4)(i)(G) of this section.

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

(J) Repeat the steps in paragraphs (b)(4)(i)(B) through (b)(4)(i)(I) of this section 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 paragraph (b)(4)(i)(A) of this section.

(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 paragraphs (b)(4)(i)(B) through (b)(4)(i)(J) of this section.

(L) The dynamometer vehicle loading is considered acceptable if, for each test vehicle, the average values determined in paragraph (b)(4)(i)(K) of this section 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.

(ii) 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.

(iii) 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.

(iv) 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).

(v) 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.

(vi) Warm-up System Check. The dynamometer warm-up system shall be checked for compliance with the requirements in paragraph (b)(3) of this section 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. 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.

(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 (c)(6) of this section, 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)(3). 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 4th 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 paragraph (d)(4) of this section 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 paragraph (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 paragraph (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 paragraph (d)(1) of this section, 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 1.0 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 paragraph (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 paragraph (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. FID gas shall be propane. Multi-component gases may be used after approval by the Administrator.

(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% 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. *(Reserved)*

(f) Overall System Performance

(1) Emission Levels. For each test lane, the average, median, 10th percentile and 90th 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, 10th percentile and 90th 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(a)(2)(v)(D) shall require corrective action.

(b) Evaporative Pressure System Check

(1) Daily Check. Relevant parameters of the evaporative system integrity analysis system shall be checked on each operating day. At a minimum, systems that monitor pressure leak down shall be checked for integrity. If, after the canister 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, official testing shall be automatically prevented until corrective action is taken.

(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.

§85.2239 Test Report - IM240 and Evaporative Tests

(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. 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)(2) through §85.2205(a)(4), 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)(2) through §85.2205(a)(4) 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)(1) through §85.2205(a)(4) and exceed the Two Ways to Pass Standard as described in §85.2205(a)(5), then the vehicle shall fail for that component and the composite score shall be reported.

(iv) If a pass or fail 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 paragraphs §85.2205(a)(4) and §85.2205(c)(3), the pass/fail results and reported emissions levels shall be those obtained at the time the test is terminated.

(4) Purge Scores. The reported 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)(2), then the vehicle shall fail.

(ii) If a pass or fail 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 paragraphs §85.2205(a)(4) and §85.2205(c)(3), the pass/fail result and reported cumulative purge levels shall be those obtained at the time the test is terminated.

(5) 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.

(6) Second-by-Second Measurements. For vehicles failing the IM240, a table or graph showing the second-by-second emission levels, for each exhaust component in grams per second, and for purge in liters per second shall be made available to the motorist or repair technician. This may be accomplished either by including it in the test report, or by making it available directly to any repair provider through electronic means within a reasonable interval after completion of the test.

§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)	CO2:	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