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July 2004

Acceleration Simulation Mode Test Procedures, Emission Standards, Quality Control Requirements, and Equipment Specifications

Final Technical Guidance

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Certification and Compliance Division
Office of Transportation and Air Quality
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NOTICE
This Technical Report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate an exchange of technical information and to inform the public of technical developments.

§85.1 Test Standards and Calculations

(a) Emissions Standards

(1) Start-up ASM Standards

Start-up standards should be used during the first cycle of the program. The exhaust emissions standards for the following model years and vehicle types are cross-referenced by the number in the column in §85.1(a)(4), as noted in the column headings:

(i) Light Duty Vehicles.

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1996+	1	21	41
1991-1995	2	22	42
1983-1990	4	23	43
1981-1982	4	26	43
1980	4	26	48
1977-1979	11	30	48
1975-1976	11	30	50
1973-1974	13	34	50
1968-1972	13	34	51

(ii) High-Altitude Light Duty Vehicles.

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1983-1984	4	26	43
1982	4	29	43

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

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1996+ ≤3750 LVW	1	21	41
1996+ >3750 LVW	2	22	42
1991-1995	5	26	43
1988-1990	7	29	44
1984-1987	7	29	49
1979-1983	11	31	49
1975-1978	12	32	50

1973-1974	13	34	50
1968-1972	13	34	51

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

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(3)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1991+	6	28	43
1988-1990	9	30	44
1984-1987	9	30	49
1982-1983	12	33	49

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

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1996+ ≤5750 LVW	2	22	42
1996+ >5750 LVW	5	26	45
1991-1995	5	26	46
1988-1990	7	29	47
1984-1987	7	29	49
1979-1983	11	31	49
1975-1978	12	32	50
1973-1974	13	34	50
1968-1972	13	34	51

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

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1991+	6	28	46
1988-1990	9	30	47
1984-1987	9	30	49
1982-1983	12	33	49

(2) Original Final ASM Standards

The following exhaust emissions standards are designed to achieve the emission reduction credits issued by EPA. They should only be used after at least one cycle of operation using the start-up standards in §85.1(a)(1). The exhaust emissions standards for the following model years and vehicle types are cross-referenced by the number in the column in §85.1(a)(4), as noted in the column headings.

Revised Final Standards are provided in §85.1(a)(3) below. Use of these Revised Final Standards will provide the same emission reduction credits available as use of the Original Final ASM Standards. It is permissible to use combinations of the Original

Final and Revised Final Standards, e.g. a state may implement the Original Final Standards for LDTs and the Revised Final Standards for LDVs.

(i) Light Duty Vehicles.

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1996+	1	21	41
1983-1995	1	21	41
1981-1982	1	23	41
1980	1	23	45
1977-1979	6	27	45
1975-1976	6	27	48
1973-1974	10	32	48
1968-1972	10	32	49

(ii) High-Altitude Light Duty Vehicles.

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1983-1984	2	23	41
1982	2	23	41

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

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1996+	1	21	41
1988-1995	3	24	42
1984-1987	3	24	46
1979-1983	8	28	46
1975-1978	9	29	48
1973-1974	10	32	48
1968-1972	10	32	49

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

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1988+	4	26	42
1984-1987	4	26	46
1982-1983	9	30	46

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

Model Years	Hydrocarbons	Carbon Monoxide	Oxides of Nitrogen

	Table §85.1 (a)(4)(i)	Table §85.1 (a)(4)(ii)	Table §85.1 (a)(4)(iii)
1996+	1	21	41
1988-1995	3	24	44
1984-1987	3	24	46
1979-1983	8	28	46
1975-1978	9	29	48
1973-1974	10	32	48
1968-1972	10	32	49

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

Model Years	Hydrocarbons Table §85.1 (a)(4)(i)	Carbon Monoxide Table §85.1 (a)(4)(ii)	Oxides of Nitrogen Table §85.1 (a)(4)(iii)
1988+	4	26	44
1984-1987	4	26	46
1982-1983	9	30	46

(3) Revised Final ASM Standards

The following exhaust emissions standards are designed to achieve the emission reduction credits issued by EPA. They should only be used after at least one cycle of operation using the start-up standards in §85.1(a)(1). The Revised Final Standards are of the form depicted below.

Vehicle Engine Displacement (l) * Avg Emission <= Revised Standard*

The Avg Emission is defined in §85.1(b)(1)(iv) and the vehicle shall pass the appropriate ASM test if the product of Engine Displacement and the respective Avg Emission is less than or equal to the Revised Standard for all three pollutants (HC, CO & NO).

NOTE: The only exception to the form described above is for the ASM2525 LDT1 HC standards. In this one case, the standards listed for HC in 85.1(3)(iv) below, are to be compared directly to the Avg HC reading as defined in §85.1(b)(1)(iv). If the Avg HC measurement is less than the Revised Standard, the vehicle's HC emissions are to receive a passing grade. This deviation from the procedure described above is only to be used for the HC ASM2525 LDT1 Revised Standards.

It is permissible to use combinations of the Original Final and Revised Final Standards, e.g. a state may implement the Original Final Standards for LDTs and the Revised Final Standards for LDVs.

* The units of the Revised Standard are (ppm * liter) for HC and NO and (%* liter) for CO.

There are no High Altitude or Light Duty Truck 2 Revised Final Standards available at this time.

(i) ASM5015 Light Duty Vehicles

Pollutant	MY	Revised Standard
HC	1980+	275
CO	1980-1982	1.3
	1983+	1.1
NO	1980	8,500
	1981+	3,600

(ii) ASM2525 Light Duty Vehicles

Pollutant	MY	Revised Standard
HC	1980-1989	500
	1990+	300
CO	1980-1982	2.3
	1983+	1.6
NO	1980	4,750
	1981+	3,500

(iii) ASM5015 Light Duty Trucks 1 (less than 6000 pounds GVWR)

Pollutant	MY	Revised Standard
HC	1980-1983	1140
	1984-1995	537
	1996+	275
CO	1980-1983	9.7
	1984-1995	5.4
	1996+	1.1
NO	1980-1987	14,145
	1988-1995	7,380
	1996+	6,150

(iv) ASM2525 Light Duty Trucks 1 (less than 6000 pounds GVWR)

Pollutant	MY	Revised Standard
HC[*]	1980-1983	340
	1984-1995	160
	1996+	82
CO	1980-1983	23.28
	1984-1995	12.96
	1996+	4.4
NO	1980-1987	32,200
	1988-1995	16,800
	1996+	14,000

[*] See NOTE above in §85.1(3) regarding the application of the HC ASM2525 LDT1 Revised Standards.

(4) ASM 2525 and 5015 Concentration Tables for Phase-In & Original Final Standards

(i) ASM2525 and ASM5015 Hydrocarbon (ppm C6) Table

Column #	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13
ETW	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525
1750	142	136	224	216	257	249	291	282	324	315	374	364	390	381	407	397	457	447	706	694	774	761	843	828	111	109
1875	134	129	212	205	243	236	275	266	306	297	353	344	368	359	384	375	431	421	665	653	729	717	794	780	105	103
2000	127	123	201	194	230	223	260	252	289	281	333	325	348	339	363	354	407	398	627	616	688	676	749	736	992	975
2125	121	116	191	184	219	212	246	239	274	267	316	308	329	321	343	335	385	376	592	582	650	638	707	695	938	921
2250	115	111	182	175	208	201	234	227	260	253	299	292	312	305	325	318	365	357	560	551	615	604	669	658	887	872
2375	109	106	173	167	198	192	223	216	247	241	284	277	297	290	309	302	346	339	531	522	583	573	635	624	841	827
2500	105	101	166	160	189	183	212	206	236	230	271	264	283	276	294	288	329	322	505	496	554	544	603	593	800	786
2625	100	97	159	153	181	175	203	197	225	219	259	252	270	263	281	274	314	307	481	472	528	518	574	564	761	748
2750	96	93	152	147	173	168	194	189	216	210	247	241	258	252	269	262	300	294	459	451	503	495	548	539	726	714
2875	92	89	146	141	167	161	187	181	207	201	237	231	247	241	257	251	287	281	439	431	481	473	524	515	695	683
3000	89	86	141	136	160	155	180	174	199	194	228	222	237	232	247	241	276	270	420	413	461	453	502	493	666	654
3125	86	83	136	132	155	150	173	168	191	186	219	214	228	223	238	232	265	260	404	397	443	435	482	474	639	628
3250	83	80	132	127	149	145	167	162	185	180	211	206	220	215	229	224	256	250	388	382	426	419	464	456	615	604
3375	81	78	128	123	145	140	162	157	179	174	204	199	213	208	221	216	247	241	374	368	411	404	447	440	593	583
3500	78	76	124	120	140	136	157	152	173	169	198	193	206	201	214	209	239	234	362	355	397	390	432	424	573	563
3625	76	74	120	117	136	132	152	148	168	164	192	187	200	195	207	203	231	226	350	344	384	377	418	411	554	544
3750	74	72	117	114	133	129	148	144	163	159	186	182	194	189	201	197	224	220	339	333	372	365	405	398	537	527
3875	72	70	114	111	129	125	144	140	159	155	181	177	188	184	196	191	218	213	329	323	361	355	393	386	521	512
4000	71	68	112	108	126	122	140	137	155	151	176	172	183	179	191	186	212	208	320	314	351	345	382	375	506	497
4125	69	67	109	106	123	119	137	133	151	147	172	168	179	175	186	181	206	202	311	305	341	335	371	365	492	484
4250	67	65	107	103	120	117	134	130	147	143	167	164	174	170	181	177	201	197	303	297	332	326	361	355	479	471
4375	66	64	104	101	118	114	131	127	144	140	164	160	170	166	177	173	196	192	295	290	323	318	352	346	467	459
4500	65	63	102	99	115	112	128	124	141	137	160	156	166	162	172	169	192	188	287	282	315	310	343	337	455	447
4625	63	61	100	97	113	109	125	122	137	134	156	152	162	159	169	165	187	183	280	275	308	302	335	329	444	436
4750	62	60	98	95	110	107	122	119	134	131	153	149	159	155	165	161	183	179	273	269	300	295	327	321	433	425
4875	61	59	96	93	108	105	120	117	132	128	149	146	155	152	161	157	179	175	267	262	293	288	319	313	423	415
5000	60	58	94	92	106	103	117	114	129	126	146	143	152	148	157	154	175	171	260	256	286	281	311	305	412	405
5125	58	57	93	90	104	101	115	112	126	123	143	139	148	145	154	150	171	167	254	250	279	274	304	298	402	395
5250	57	56	91	88	102	99	112	110	123	120	140	136	145	142	150	147	167	163	248	244	272	267	296	291	393	386
5375	56	55	89	86	100	97	110	107	121	118	137	133	142	139	147	144	163	159	242	238	266	261	289	284	383	376
5500	55	54	87	85	98	95	108	105	118	115	134	130	139	136	144	141	159	156	236	232	259	255	282	277	374	367
5625	54	53	86	83	96	93	106	103	116	113	131	128	136	133	141	138	156	152	231	226	253	248	276	271	365	359
5750	53	52	84	82	94	91	104	101	113	111	128	125	133	130	138	135	152	149	225	221	247	243	269	264	357	350
5875	52	51	83	80	92	90	102	99	111	108	125	122	130	127	135	132	149	146	220	216	241	237	263	258	348	342
6000	51	50	81	79	90	88	100	97	109	106	123	120	127	124	132	129	146	143	215	211	236	232	257	252	341	334
6125	50	49	80	78	89	86	98	95	107	104	120	118	125	122	129	126	143	140	210	206	231	227	251	247	333	327
6250	50	48	79	76	87	85	96	94	105	102	118	115	123	120	127	124	140	137	206	202	226	222	246	242	326	320
6375	49	48	77	75	86	84	95	92	103	101	116	113	120	118	125	122	138	135	202	198	222	218	242	237	320	314
6500	48	47	76	74	85	83	93	91	102	99	114	112	119	116	123	120	136	133	199	195	218	214	238	233	315	309
6625	48	46	76	74	84	82	92	90	101	98	113	110	117	114	121	119	134	131	196	192	215	211	234	230	310	304
6750	47	46	75	73	83	81	91	89	100	97	112	109	116	113	120	117	132	129	194	190	213	209	232	227	307	301
6875	47	46	75	73	83	81	91	89	99	97	111	109	115	113	119	117	132	129	193	189	211	207	230	225	305	299
7000	47	46	74	72	83	80	91	88	99	96	111	108	115	112	119	116	131	128	192	188	211	207	229	225	304	298
7125	47	46	74	72	82	80	90	88	98	96	111	108	115	112	119	116	131	128	192	188	211	206	229	225	304	298
7250	47	46	74	72	82	80	90	88	98	96	111	108	115	112	119	116	131	128	192	188	211	206	229	225	304	298
7375	47	46	74	72	82	80	90	88	98	96	111	108	115	112	119	116	131	128	192	188	211	206	229	225	304	298
7500	47	46	74	72	82	80	90	88	98	96	111	108	115	112	119	116	131	128	192	188	211	206	229	225	304	298

(ii) ASM2525 and ASM5015 Carbon Monoxide (%CO) Table

Column #	21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	34	34
ETW	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525
1750	0.80	0.77	1.26	1.22	1.64	1.83	2.02	2.43	2.21	2.73	2.78	3.64	2.97	3.94	3.16	4.24	3.54	4.85	3.92	5.45	4.31	6.06	5.07	7.26	5.26	7.44	8.02	9.90
1875	0.75	0.73	1.19	1.16	1.55	1.72	1.91	2.29	2.09	2.58	2.63	3.43	2.81	3.71	2.98	4.00	3.34	4.57	3.70	5.14	4.06	5.70	4.78	6.84	4.96	7.05	7.56	9.90
2000	0.71	0.69	1.13	1.09	1.47	1.63	1.81	2.17	1.97	2.43	2.48	3.24	2.65	3.51	2.82	3.77	3.16	4.31	3.49	4.85	3.83	5.38	4.51	6.45	4.68	6.68	7.14	9.90
2125	0.68	0.66	1.07	1.04	1.39	1.54	1.71	2.05	1.87	2.30	2.35	3.06	2.51	3.32	2.67	3.57	2.99	4.08	3.31	4.58	3.63	5.09	4.26	6.10	4.43	6.34	6.75	9.66
2250	0.64	0.62	1.02	0.99	1.32	1.47	1.62	1.94	1.77	2.18	2.23	2.90	2.38	3.14	2.53	3.38	2.83	3.86	3.13	4.34	3.44	4.82	4.04	5.78	4.20	6.00	6.40	9.14
2375	0.61	0.59	0.97	0.94	1.26	1.39	1.54	1.85	1.69	2.07	2.12	2.76	2.26	2.98	2.40	3.21	2.69	3.66	2.98	4.12	3.26	4.57	3.83	5.48	3.98	5.69	6.07	8.67
2500	0.59	0.57	0.93	0.90	1.20	1.33	1.47	1.76	1.61	1.97	2.02	2.62	2.15	2.84	2.29	3.05	2.56	3.48	2.83	3.91	3.10	4.35	3.65	5.21	3.79	5.41	5.78	8.25
2625	0.56	0.54	0.89	0.86	1.15	1.27	1.41	1.68	1.53	1.88	1.92	2.50	2.05	2.70	2.18	2.91	2.44	3.32	2.70	3.73	2.96	4.14	3.48	4.96	3.61	5.15	5.51	7.85
2750	0.54	0.52	0.85	0.82	1.10	1.21	1.34	1.60	1.47	1.80	1.84	2.39	1.96	2.58	2.09	2.78	2.33	3.17	2.58	3.56	2.83	3.95	3.32	4.73	3.45	4.92	5.26	7.50
2875	0.52	0.50	0.82	0.79	1.05	1.16	1.29	1.54	1.41	1.72	1.76	2.29	1.88	2.47	2.00	2.66	2.23	3.03	2.47	3.41	2.71	3.78	3.18	4.53	3.30	4.70	5.03	7.17
3000	0.50	0.48	0.79	0.76	1.01	1.12	1.24	1.48	1.35	1.66	1.69	2.19	1.80	2.37	1.92	2.55	2.14	2.91	2.37	3.27	2.60	3.62	3.05	4.34	3.17	4.51	4.83	6.87
3125	0.48	0.46	0.76	0.73	0.98	1.08	1.19	1.42	1.30	1.59	1.63	2.11	1.74	2.28	1.84	2.45	2.06	2.79	2.28	3.14	2.50	3.48	2.93	4.17	3.04	4.33	4.64	6.60
3250	0.46	0.45	0.73	0.71	0.94	1.04	1.15	1.37	1.26	1.53	1.57	2.03	1.67	2.20	1.78	2.36	1.99	2.69	2.20	3.02	2.40	3.35	2.82	4.01	2.93	4.17	4.47	6.35
3375	0.45	0.43	0.71	0.69	0.91	1.00	1.11	1.32	1.21	1.48	1.52	1.96	1.62	2.12	1.72	2.28	1.92	2.60	2.12	2.91	2.32	3.23	2.72	3.87	2.83	4.02	4.31	6.13
3500	0.44	0.42	0.69	0.67	0.88	0.97	1.08	1.28	1.17	1.43	1.47	1.89	1.56	2.05	1.66	2.20	1.86	2.51	2.05	2.82	2.24	3.12	2.63	3.74	2.73	3.88	4.17	5.92
3625	0.42	0.41	0.67	0.65	0.86	0.94	1.05	1.24	1.14	1.39	1.42	1.84	1.52	1.98	1.61	2.13	1.80	2.43	1.99	2.73	2.17	3.02	2.55	3.62	2.65	3.76	4.04	5.73
3750	0.41	0.40	0.65	0.63	0.83	0.92	1.02	1.20	1.11	1.35	1.38	1.78	1.47	1.92	1.56	2.07	1.74	2.36	1.93	2.64	2.11	2.93	2.47	3.51	2.57	3.64	3.91	5.55
3875	0.40	0.39	0.63	0.61	0.81	0.89	0.99	1.17	1.08	1.31	1.34	1.73	1.43	1.87	1.52	2.01	1.69	2.29	1.87	2.57	2.05	2.85	2.40	3.40	2.49	3.54	3.80	5.39
4000	0.39	0.38	0.62	0.60	0.79	0.87	0.96	1.14	1.05	1.28	1.31	1.68	1.39	1.82	1.48	1.95	1.65	2.22	1.82	2.49	1.99	2.77	2.33	3.31	2.43	3.44	3.70	5.24
4125	0.38	0.37	0.60	0.58	0.77	0.85	0.94	1.11	1.02	1.24	1.27	1.64	1.36	1.77	1.44	1.90	1.61	2.16	1.77	2.43	1.94	2.69	2.27	3.22	2.36	3.34	3.60	5.09
4250	0.37	0.36	0.59	0.57	0.75	0.83	0.92	1.08	1.00	1.21	1.24	1.60	1.32	1.72	1.40	1.85	1.56	2.11	1.73	2.36	1.89	2.62	2.21	3.13	2.30	3.25	3.51	4.96
4375	0.36	0.35	0.58	0.56	0.74	0.81	0.89	1.06	0.97	1.18	1.21	1.56	1.29	1.68	1.37	1.81	1.53	2.06	1.68	2.31	1.84	2.55	2.16	3.05	2.24	3.17	3.42	4.83
4500	0.36	0.35	0.57	0.55	0.72	0.79	0.87	1.03	0.95	1.16	1.18	1.52	1.26	1.64	1.34	1.76	1.49	2.01	1.64	2.25	1.80	2.49	2.11	2.98	2.19	3.09	3.34	4.71
4625	0.35	0.34	0.55	0.54	0.70	0.77	0.85	1.01	0.93	1.13	1.15	1.48	1.23	1.60	1.30	1.72	1.46	1.96	1.61	2.19	1.76	2.43	2.06	2.90	2.14	3.02	3.26	4.60
4750	0.34	0.33	0.54	0.53	0.69	0.76	0.84	0.99	0.91	1.10	1.13	1.45	1.20	1.57	1.28	1.68	1.42	1.91	1.57	2.14	1.72	2.37	2.01	2.83	2.09	2.95	3.18	4.49
4875	0.34	0.33	0.53	0.52	0.67	0.74	0.82	0.97	0.89	1.08	1.10	1.42	1.17	1.53	1.25	1.64	1.39	1.87	1.53	2.09	1.68	2.32	1.96	2.77	2.04	2.87	3.11	4.38
5000	0.33	0.32	0.52	0.51	0.66	0.73	0.80	0.95	0.87	1.05	1.08	1.38	1.15	1.49	1.22	1.60	1.36	1.82	1.50	2.04	1.64	2.26	1.92	2.70	1.99	2.81	3.03	4.28
5125	0.32	0.31	0.51	0.50	0.65	0.71	0.78	0.92	0.85	1.03	1.05	1.35	1.12	1.46	1.19	1.57	1.33	1.78	1.46	2.00	1.60	2.21	1.87	2.64	1.95	2.74	2.97	4.18
5250	0.32	0.31	0.50	0.49	0.63	0.70	0.77	0.90	0.83	1.01	1.03	1.32	1.10	1.43	1.16	1.53	1.30	1.74	1.43	1.95	1.56	2.16	1.83	2.58	1.90	2.68	2.90	4.08
5375	0.31	0.30	0.49	0.48	0.62	0.68	0.75	0.89	0.81	0.99	1.01	1.29	1.07	1.39	1.14	1.50	1.27	1.70	1.40	1.90	1.53	2.11	1.79	2.51	1.86	2.61	2.83	3.98
5500	0.30	0.30	0.48	0.47	0.61	0.67	0.73	0.87	0.80	0.97	0.99	1.26	1.05	1.36	1.11	1.46	1.24	1.66	1.37	1.86	1.49	2.06	1.75	2.46	1.82	2.55	2.77	3.89
5625	0.30	0.29	0.47	0.46	0.59	0.65	0.72	0.85	0.78	0.94	0.97	1.24	1.03	1.33	1.09	1.43	1.21	1.62	1.34	1.82	1.46	2.01	1.71	2.40	1.77	2.49	2.70	3.80
5750	0.29	0.29	0.46	0.45	0.58	0.64	0.70	0.83	0.76	0.92	0.94	1.21	1.01	1.30	1.07	1.40	1.19	1.59	1.31	1.78	1.43	1.96	1.67	2.34	1.74	2.43	2.64	3.71
5875	0.29	0.28	0.45	0.44	0.57	0.63	0.69	0.81	0.75	0.91	0.92	1.18	0.98	1.27	1.04	1.37	1.16	1.55	1.28	1.74	1.40	1.92	1.63	2.29	1.70	2.38	2.59	3.62
6000	0.28	0.28	0.44	0.44	0.56	0.62	0.67	0.80	0.73	0.89	0.91	1.16	0.96	1.25	1.02	1.34	1.14	1.52	1.25	1.70	1.37	1.88	1.60	2.24	1.66	2.33	2.53	3.54
6125	0.28	0.27	0.44	0.43	0.55	0.61	0.66	0.78	0.72	0.87	0.89	1.13	0.94	1.22	1.00	1.31	1.11	1.49	1.23	1.66	1.34	1.84	1.57	2.19	1.63	2.28	2.48	3.47
6250	0.27	0.27	0.43	0.42	0.54	0.60	0.65	0.77	0.71	0.85	0.87	1.11	0.93	1.20	0.98	1.28	1.09	1.46	1.20	1.63	1.31	1.80	1.54	2.15	1.60	2.23	2.43	3.40
6375	0.27	0.26	0.42	0.42	0.53	0.59	0.64	0.76	0.69	0.84	0.86	1.09	0.91	1.18	0.96	1.26	1.07	1.43	1.18	1.60	1.29	1.77	1.51	2.11	1.57	2.19	2.39	3.34
6500	0.26	0.26	0.42	0.41	0.52	0.58	0.63	0.74	0.68	0.83	0.84	1.08	0.90	1.16	0.95	1.24	1.06	1.41	1.16	1.57	1.27	1.74	1.48	2.07	1.54	2.15	2.35	3.28
6625	0.26	0.26	0.41	0.41	0.52	0.57	0.62	0.73	0.67	0.82	0.83	1.06	0.88	1.14	0.94	1.23	1.04	1.39	1.15	1.55	1.25	1.72	1.46	2.04	1.52	2.12	2.32	3.23
6750	0.26	0.26	0.41	0.41	0.51	0.57	0.61	0.73	0.67	0.81	0.82	1.05	0.88	1.13	0.93	1.21	1.03	1.37	1.14	1.54	1.24	1.70	1.45	2.02	1.50	2.10	2.29	3.20
6875	0.26	0.25	0.40	0.40	0.51	0.56	0.61	0.72	0.66	0.80	0.82	1.04	0.87	1.12	0.92	1.20	1.02	1.36	1.13	1.52	1.23	1.68	1.44	2.00	1.49	2.08	2.28	3.17
7000	0.25	0.25	0.40	0.40	0.51	0.56	0.61	0.72	0.66	0.80	0.82	1.04	0.87	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.23	1.68	1.43	2.00	1.49	2.08	2.27	3.17
7125	0.25	0.25	0.40	0.40	0.51	0.56	0.61	0.72	0.66	0.80	0.81	1.04	0.87	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.22	1.68	1.43	2.00	1.49	2.08	2.27	3.17
7250	0.25	0.25	0.40	0.40	0.50	0.56	0.61	0.72	0.66	0.80	0.81	1.04	0.86	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.22	1.68	1.43	2.00	1.49	2.08	2.27	3.17
7375	0.25	0.25	0.40	0.40	0.50	0.56	0.61	0.72	0.66	0.80	0.81	1.04	0.86	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.22	1.68	1.43	2.00	1.49	2.08	2.27	3.17
7500	0.25	0.25	0.40	0.40	0.50	0.56	0.61	0.72	0.66	0.80	0.81	1.04	0.86	1.12	0.92	1.20	1.02	1.36	1.12	1.52	1.22	1.68	1.43	2.00	1.49	2.08	2.27	3.17

(iii) ASM2525 and ASM5015 Nitric Oxide (ppm NO) Table

Column #	41	41	42	42	43	43	44	44	45	45	46	46	47	47	48	48	49	49	50	50	51	51
ETW	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525	5015	2525
1750	1212	1095	1819	1642	2272	2114	2725	2587	3178	3060	3631	3532	4084	4005	4990	4950	4990	4960	4990	4980	4990	4990
1875	1142	1031	1713	1547	2181	1991	2649	2435	3117	2879	3586	3323	4054	3767	4990	4655	4990	4738	4990	4906	4990	4990
2000	1077	973	1616	1460	2058	1877	2499	2295	2941	2713	3383	3131	3824	3548	4707	4384	4778	4535	4919	4838	4990	4990
2125	1018	920	1527	1380	1944	1774	2360	2167	2776	2561	3192	2955	3609	3348	4441	4136	4578	4349	4853	4776	4990	4990
2250	964	871	1446	1307	1839	1678	2232	2050	2625	2422	3018	2794	3411	3165	4197	3909	4395	4179	4792	4720	4990	4990
2375	915	827	1372	1240	1744	1592	2115	1943	2487	2295	2859	2646	3231	2998	3974	3701	4228	4024	4736	4668	4990	4990
2500	869	786	1304	1179	1657	1512	2009	1845	2361	2179	2714	2512	3066	2845	3771	3512	4076	3881	4685	4620	4990	4990
2625	828	749	1242	1123	1577	1440	1912	1756	2246	2073	2581	2389	2916	2706	3585	3339	3936	3752	4639	4577	4990	4990
2750	791	715	1186	1072	1504	1374	1823	1675	2142	1976	2460	2277	2779	2579	3416	3181	3809	3579	4596	4374	4990	4772
2875	756	684	1134	1026	1438	1313	1742	1601	2046	1888	2350	2175	2654	2463	3261	3037	3669	3417	4484	4176	4892	4556
3000	725	656	1088	984	1378	1258	1668	1533	1959	1808	2249	2082	2539	2357	3120	2906	3510	3270	4290	3996	4680	4359
3125	696	630	1045	945	1323	1208	1601	1471	1879	1734	2157	1997	2435	2260	2992	2787	3366	3135	4114	3832	4488	4180
3250	670	607	1006	910	1273	1163	1539	1415	1806	1667	2073	1920	2340	2172	2874	2677	3234	3012	3952	3681	4311	4016
3375	647	585	970	878	1227	1121	1483	1363	1740	1606	1997	1849	2253	2092	2767	2577	3113	2899	3804	3544	4150	3866
3500	625	566	937	848	1184	1082	1432	1316	1679	1550	1926	1784	2174	2018	2668	2486	3002	2796	3669	3418	4002	3728
3625	605	547	907	821	1146	1047	1384	1273	1623	1498	1862	1724	2100	1950	2578	2401	2900	2701	3544	3302	3867	3602
3750	586	531	879	796	1110	1014	1340	1233	1571	1451	1802	1669	2033	1887	2494	2323	2806	2614	3429	3195	3741	3485
3875	569	515	853	773	1077	984	1300	1195	1523	1407	1747	1618	1970	1829	2417	2251	2719	2533	3323	3096	3625	3377
4000	553	501	829	751	1046	956	1262	1161	1479	1365	1695	1570	1912	1775	2345	2184	2638	2457	3224	3003	3517	3276
4125	538	487	807	731	1017	930	1227	1128	1437	1327	1647	1526	1857	1724	2277	2122	2562	2387	3131	2917	3416	3182
4250	524	475	786	712	990	905	1194	1098	1398	1291	1602	1484	1806	1677	2214	2063	2490	2320	3044	2836	3321	3094
4375	510	463	766	694	964	882	1162	1069	1360	1257	1559	1444	1757	1632	2154	2007	2423	2258	2961	2759	3230	3010
4500	498	451	747	677	939	859	1132	1042	1325	1224	1518	1406	1711	1589	2096	1953	2359	2198	2883	2686	3145	2930
4625	486	440	728	661	916	838	1104	1015	1291	1193	1479	1370	1666	1548	2042	1903	2297	2140	2807	2616	3063	2854
4750	474	430	711	645	893	818	1076	990	1259	1163	1441	1336	1624	1508	1989	1854	2238	2085	2735	2549	2983	2780
4875	463	420	694	630	872	798	1049	966	1227	1134	1405	1302	1583	1470	1938	1806	2180	2032	2665	2483	2907	2709
5000	452	410	677	615	850	778	1023	942	1196	1106	1369	1269	1542	1433	1889	1760	2125	1980	2597	2420	2833	2640
5125	441	400	661	600	830	760	998	919	1167	1078	1335	1237	1503	1397	1840	1715	2070	1930	2530	2359	2760	2573
5250	431	391	646	586	810	741	974	896	1138	1051	1301	1206	1465	1362	1793	1672	2017	1881	2466	2298	2690	2507
5375	420	382	631	573	790	723	950	874	1109	1025	1269	1176	1428	1327	1747	1629	1966	1833	2403	2240	2621	2443
5500	410	373	616	559	771	706	926	853	1082	1000	1237	1147	1392	1294	1703	1587	1916	1786	2341	2183	2554	2381
5625	401	364	601	546	752	689	904	832	1055	975	1206	1118	1357	1261	1659	1547	1867	1740	2282	2127	2489	2321
5750	391	356	587	534	734	673	882	812	1029	951	1176	1090	1323	1230	1617	1508	1820	1697	2224	2074	2426	2262
5875	383	348	574	522	717	657	860	793	1004	928	1147	1064	1290	1199	1577	1471	1774	1654	2168	2022	2366	2206
6000	374	340	561	510	701	642	840	774	980	906	1120	1039	1259	1171	1539	1435	1731	1614	2116	1973	2308	2152
6125	366	333	549	499	685	628	822	757	958	886	1094	1015	1230	1144	1503	1401	1690	1577	2066	1927	2254	2102
6250	359	326	538	489	671	615	804	741	937	867	1070	993	1203	1119	1469	1371	1653	1542	2020	1884	2204	2056
6375	352	320	528	480	658	604	788	727	919	850	1049	973	1179	1096	1439	1343	1619	1510	1979	1846	2159	2014
6500	346	315	519	473	647	593	775	714	902	835	1030	956	1158	1077	1413	1318	1590	1483	1943	1813	2119	1977
6625	341	311	512	466	638	585	763	704	889	823	1014	941	1140	1060	1391	1298	1565	1460	1913	1785	2087	1947
6750	338	307	507	461	631	578	755	696	879	813	1003	931	1127	1048	1374	1283	1546	1443	1890	1764	2062	1924
6875	335	305	503	458	626	574	749	691	872	807	995	924	1118	1040	1364	1273	1534	1432	1875	1750	2046	1909
7000	335	305	502	457	624	573	747	689	870	805	992	921	1115	1037	1360	1269	1530	1428	1870	1745	2040	1904
7125	335	305	502	457	625	573	747	689	870	805	992	921	1115	1037	1360	1269	1531	1428	1874	1745	2045	1904
7250	335	305	502	457	625	573	747	689	870	805	992	921	1115	1037	1360	1269	1531	1428	1874	1745	2045	1904
7375	335	305	502	457	625	573	747	689	870	805	992	921	1115	1037	1360	1269	1531	1428	1874	1745	2045	1904
7500	335	305	502	457	625	573	747	689	870	805	992	921	1115	1037	1360	1269	1531	1428	1874	1745	2045	1904

(b) Test Score Calculation

(1) Exhaust Gas Measurement Calculation.

(i) Measurement Start. The analysis and recording of exhaust gas concentrations shall begin 15 seconds after the applicable test mode begins, or sooner if the system response time (to 95% of full scale) is less than 15 seconds. The analysis and recording of exhaust gas concentrations shall not begin sooner than the time period equivalent to the response time of the slowest transducer.

(ii) Sample Rate. Exhaust gas concentrations shall be analyzed at a minimum rate of once per second.

(iii) Negative Values. Negative concentration readings shall be integrated as zero and recorded as such.

(iv) Emission Measurement Calculations. Partial stream (concentration) emissions shall be calculated based on a running 10 second average. The values used for HC(j), CO(j), and NO(j) are the raw (uncorrected) tailpipe concentrations.

(A) $$\mathrm{AvgHC} = \frac{\sum_{j=1}^{10} \mathrm{HC}(j) * \mathrm{DCF}(j)}{10}$$

(B) $$\mathrm{AvgCO} = \frac{\sum_{j=1}^{10} \mathrm{CO}(j) * \mathrm{DCF}(j)}{10}$$

(C) $$\mathrm{AvgNO} = \frac{\sum_{j=1}^{10} \mathrm{NO}(j) * \mathrm{DCF}(j)}{10} * K_h$$

(v) Dilution Correction Factor. The analyzer software shall multiply the raw emissions values by the Dilution Correction Factor (DCF) during any valid ASM emissions test. The DCF accounts for exhaust sample dilution (either intentional or unintentional) during an emissions test. The analyzer software shall calculate the DCF using the following procedure, and shall select the appropriate vehicle fuel formula. If the calculated DCF exceeds 3.0 then a default value of 3.0 shall be used.

(A) $$X = \frac{[CO_2]_{\mathrm{measured}}}{[CO_2]_{\mathrm{measured}} + [CO]_{\mathrm{measured}}}$$

Where $[CO_2]_{measured}$ and $[CO]_{measured}$ are the instantaneous ASM emissions test readings.

(B) Calculate $[CO_2]_{adjusted}$ using the following formulas.

(1) For Gasoline:

$$[CO_2]_{adjusted} = \frac{X}{4.644 + 1.88X} * 100$$

(2) For Methanol or Ethanol:

$$[CO_2]_{adjusted} = \frac{X}{4.73 + 1.88X} * 100$$

(3) For Compressed Natural Gas (CNG):

$$[CO_2]_{adjusted} = \frac{X}{6.64 + 1.88X} * 100$$

(4) For Liquid Propane Gas (LPG):

$$[CO_2]_{adjusted} = \frac{X}{5.39 + 1.88X} * 100$$

(C) Calculate the DCF using the following formula:

$$DCF = \frac{[CO_2]_{adjusted}}{[CO_2]_{measured}}$$

(vi) <u>NO Humidity Correction Factor</u>. The NO measurement shall be adjusted based on relative humidity using a correction factor K_h, calculated as follows:

(A) Standard Method

$$K_h = \frac{1}{1.0 - 0.0047(H - 75)}$$

Where:

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

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

Ra = Relative humidity of the ambient air, percent.

Pd = Saturated vapor pressure, mm Hg at the ambient dry bulb temperature*.

$= (-4.14438*10^{-3}) + (5.76645*10^{-3} * T_d) - (6.32788*10^{-5} * T_d^2) + (2.12294*10^{-6} * T_d^3) - (7.85415*10^{-9} * T_d^4) + (6.55263*10^{-11} * T_d^5)$

Where: T_d = Dry bulb temperature, °F

P_B = Barometric pressure, mm Hg.

(B) Revised method•

$$K_h = e^{[0.004977(H-75)-0.004447(T-75)]}$$

Where: H = Absolute humidity in grains of water per pound of dry air.

T = Temperature in °F.

NOTE: If the calculated K_H using either method of calculation is greater than 2.19, the value of K_H shall be set at 2.19.

(2) Pass/Fail Determination.

A pass or fail determination shall be made for each applicable test mode based on a comparison of the applicable test standards and the measured value for HC, CO, and NO as described in §85.1(b)(1)(iv). A vehicle shall pass the test mode if the emission values for HC, CO, and NO are simultaneously below or equal to the applicable short test standards for all three pollutants. A vehicle shall fail the test mode if the values for HC, CO, or NO, or any combination of the three, are above the applicable standards at the expiration of the test time.

* SAEJ1094, §6.1.1.3, p.38, June 1992. This equation is a least squares fit to the Keenan and Keyes "steam table." It reproduces steam table values within 0.0001 in Hg for temperatures from 20° to 110°F.

• This revised method for calculating K_h as a function of both T and H is based on work performed by Sierra Research under contract 68-C4-0056, Work Assignment 2-04. If the calculated value of K_h exceeds 2.19, the value of K_h shall be set to 2.19. This analysis used the same MY69, 5-vehicle sample employed for the original K_h factor study that resulted in the current CFR standard K_h calculation method (listed in (vi)(F) above). However, in many cases IM testing occurs outside the temperature limits set by the CFR for the standard method; therefore, at this time EPA recommends using the revised method when testing above 86°F. The new method makes the calculation of K_h more accurate over a wider range of temperatures.

§85.2 Test Procedures

(a) General Requirements.

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

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

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

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

(4) Void Test Conditions. The test shall immediately end and any exhaust gas measurements shall be voided if the instantaneous measured concentration of CO plus CO_2 falls below six percent or the vehicle's engine stalls at any time during the test sequence.

(5) Vehicle Brakes. The vehicle's brakes shall not be applied during the test modes. If the vehicle's brakes are applied during testing the mode timer shall be reset to zero (tt = 0). Some dynamometers do not have the ability to automatically sense if a vehicle's brakes become engaged. In these instances, it shall be the responsibility of the Program to implement technician training and test procedures so that a test shall be manually restarted if the vehicle's brakes are applied.

(6) Test Termination. The test shall be aborted or terminated upon reaching the overall maximum test time.

(b) Vehicle 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) Traction Control and Four-Wheel Drive (AWD). Most vehicles with traction control can be tested on AWD dynamometers; however, this is not true for all vehicles and dynamometer models.

Vehicles with traction control systems that cannot be turned off shall not be tested on two wheel drive dynamometers. Vehicles with AWD that cannot be turned off shall only be tested on AWD dynamometers. If the AWD function can be disabled, then AWD vehicles may be tested on two wheel drive dynamometers.

It is the responsibility of all vehicle OEMs to notify the Certification and Compliance Division of EPA in writing of any vehicles that can't be tested on AWD dynamometers so that EPA may share this information with state IM programs.

(c) Exhaust 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.

(4) Fluid Leaks. The vehicle shall be inspected for fluid leaks. Vehicles with leaking engine oil, transmission fluid, or coolant shall be rejected from testing.

(5) Mechanical Condition. Vehicles with obvious mechanical problems (engine, transmission, brakes, or exhaust) that either create a safety hazard or could bias test results shall be rejected from testing.

(6) Operating Temperature. The vehicle shall be at normal operating temperature prior to the start of the test. The vehicle temperature gauge, if equipped and operating, shall be checked to assess temperature. Vehicles in overheated condition shall be rejected from testing.

(7) Tire Condition. Vehicles shall be rejected from testing if tread indicators, tire cords, bubbles, cuts, or other damage are visible. Vehicles shall be rejected from testing if they have space-saver spare tires or if they do not have reasonably sized tires on the drive axle or axles. Vehicles may be rejected if they have different sized tires on the drive axle or axles. In test-and-repair facilities, drive wheel tires shall be checked with a gauge for adequate tire pressure. In test-only facilities, drive wheel 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 vehicle manufacturer's recommendation. Alternatively, vehicles with apparent low tire pressure may be rejected from testing.

(8) Gear Selection. The vehicle shall be operated during each mode of the test with the gear selector in drive for automatic transmissions and in second (or third if more appropriate) for manual transmissions for the loaded modes.

(9) 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. Vehicles that cannot be stabilized on the dynamometer shall be rejected from testing. Drive wheel tires shall be dried if necessary to prevent slippage.

(10) Vehicle Restraint. Testing shall not begin until the vehicle is restrained. Any restraint system shall meet the requirements of §85.3(a)(5)(ii). In addition, the parking brake shall be set for front wheel drive vehicles prior to the start of the test, unless parking brake functions on front axle or if is automatically disengaged when in gear.

(11) Vehicle Conditioning.

(i) Queuing Time. When a vehicle waits in a queue more than 20 minutes or when a vehicle is shut-off for more than 5 minutes prior to the test, vehicle conditioning shall be performed for 60 seconds, as specified in §85.2(b)(12)(ii)(C) below. This 60 second period is in addition to the test times described in §85.2(d). Emissions may be monitored during this cycle and if passing readings are obtained, as specified for the ASM cycle in §85.2(d), then the cycle may be terminated and the respective ASM mode skipped.

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

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

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

(C) ASM Preconditioning. Drive the vehicle on the dynamometer using either mode of the ASM test as specified in §85.2(d).

(D) Transient Preconditioning. After maneuvering the vehicle onto the dynamometer, drive a transient cycle consisting of speed, time, acceleration, and load relationships such as the IM240.

(c) Equipment Preparation and Settings.

(1) Analyzer Warm-Up. Emission testing shall be locked out until the analyzer is warmed-up and stable. The analyzer shall reach stability within 30 minutes from startup. If an analyzer does not achieve stability within the allotted time frame, it shall remain locked out from testing. The instrument shall be considered "warmed-up" when the zero and span readings for HC, CO, NO, and CO_2 have stabilized within the accuracy values specified in §85.3(c)(3)(vi) for five minutes without adjustment.

(2) Emission Sample System Purge. While the equipment is in operation, the sample system shall be continuously purged after each test for at least 15 minutes if not taking measurements. If the equipment has been shut down, the system shall be purged for 5 minutes or until the HC reading is less than 15 ppm C6 prior to the start of a test.

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

(4) Multiple exhaust pipes. Exhaust gas concentrations from vehicle engines equipped with functionally independent multiple exhaust pipes shall be sampled simultaneously. The collection system shall be designed such that the flow through both probes is within ± 10%.

(5) Analyzer Preparation. The analyzer shall perform an automatic zero, an ambient air reading, and an HC hang-up check prior to each test. This process shall occur within two minutes of the start of the test.

(i) Automatic Gas Zero. The analyzer shall conduct automatic zero adjustments using the zero gas specified in §85.4(d)(2)(iii). The zero adjustment shall include the HC, CO, CO_2, and NO channels. Bottled or generated zero air may be used.

(ii) Ambient Air Reading. Filtered ambient air shall be introduced to the analyzer before the sample pump, but after the sample probe, hose, and filter/water trap. The analyzer shall record the concentrations of the four measured gases, but shall make no adjustments.

(1) The sample through probe has less than 15 ppm HC, 0.02% CO, and 25 ppm NO.

(iii) HC Hang-up Determination. The analyzer shall sample ambient air through the probe to determine background pollution levels and HC hang-up. The analyzer shall be locked out from testing until:

(1) The residual HC in the sampling system (probe sample - ambient air reading) is less than 7 ppm.

(6) Cooling System. When ambient temperatures exceed 72°F, testing shall not begin until the cooling system blower is positioned 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. The use of a cooling system is optional when testing at temperatures below 50°F. If a cooling system is in use, testing shall not begin until the cooling system is positioned and activated. Furthermore, the hood may be opened at the state's discretion.

(7) Dynamometer Warm-Up. Dynamometers that do not have temperature compensation shall be automatically warmed-up prior to official testing and shall be locked out until warmed-up. Dynamometers resting (not operated for at least 30 seconds and at least 15 mph) for more than 30 minutes shall pass the coast-down check specified in §85.4(b)(1) prior to use in testing. As specified in §85.4(a)(2), control charts may be used to demonstrate allowing a longer duration of inactivity before a required warm-up.

If the dynamometer is not warmed-up as outlined above, then the parasitic losses, typically bearing and windage friction expressed as a function of velocity, shall be characterized as a function of bearing temperature or some alternative parameter that the manufacturer ca demonstrate is correlated with parasitic losses. Based on this characterization, the dynamometer load shall be automatically adjusted to compensate for changes in parasitic losses as a function of dynamometer temperature in order to ensure dynamometer load accuracy without having to perform dynamometer warm-ups.

All-wheel-drive dynamometers must characterize losses for the entire system, i.e. both roll sets. If an all-wheel-drive dynamometer can be operated in either two- or all-wheel-drive mode, parasitic losses must be characterized in both two- and all-wheel-drive modes. System software shall automatically change parasitic losses depending on how the vehicle is tested.

(8) Dynamometer Settings. Dynamometer power absorption and inertia weight settings shall be automatically chosen from an EPA-supplied or EPA-approved electronic look-up table which will be referenced based upon the vehicle identification information obtained in §85.2(a)(1)*. Vehicles not listed shall be tested using default power absorption and inertia settings in the latest version of the EPA I/M Look-up Table, as posted on EPA's web site: www.epa.gov/orcdizux/im.htm. At a minimum the look-up table on the ASM host computer should be updated once per year.

(9) Engine Speed. Engine speed measurement equipment shall be attached on all 1996 and newer light duty vehicles and trucks, and in test-and-repair programs, engine speed shall also be monitored on all pre-1996 vehicles. On vehicles equipped with OBD systems (1996 and newer), it is recommended that the SAE-standardized OBD-plug be used. Engine speed measurement equipment shall meet the requirements of §85.3(c)(5).

(d) Test Procedures.

The test sequence shall consist of either a single ASM mode or both ASM modes described in §85.2(d)(1) and (2), and may be performed in either order (with appropriate change in transition requirements in §85.2(d)(1)(iv)). Vehicles that fail the first-chance test described in §85.2(d) shall receive a second-chance test if the conditions in §85.2(e) apply. An Alternative ASM mode is described in §85.2(d)(3). This new procedure was designed to improve vehicle throughput by reducing the likelihood of failing a vehicle because it had locked into a non-representative high emitting mode of operation. Vehicles that fail the Alternative ASM Test Procedure may be granted a second-chance test at the state's discretion.

The test timer shall start (tt=0) when the conditions specified in §85.2(b) and §85.2(c) are met and the mode timer initiates as specified in §85.2(d)(1), §85.2(d)(2), or §85.2(d)(3). Maximum test times for various test scenarios are described in §85.2 (e)(1) below. The test shall be immediately terminated or aborted upon reaching the overall maximum test time.

* EPA last updated the look-up table on September 10, 1998 (I/M LOOK-UP TABLE, RELEASE 1.6.1). Since that time the table has been updated by states, contractors and consulting firms.

(1) ASM5015 Mode.

(i) The mode timer shall start (mt=0) when the dynamometer speed (and corresponding power) is maintained within 15±1.0 miles per hour for 5 continuous seconds. The dynamometer shall apply the constant torque over the duration of the ASM mode. Torque shall be set to the correct torque necessary to generate the required horsepower at 15.0 mph. If actual torque applied deviates by more than 2% from the target torque for more than two consecutive seconds, the test mode timer shall be set to mt=0.

(ii) The dynamometer power shall be automatically selected from an EPA-supplied or EPA-approved look-up table, based upon the vehicle identification information described in §85.2(a)(1). If a vehicle is not specifically listed in the EPA-approved table, default values from the same table shall be used. If an appropriate default value is not available in the EPA-approved table, ASM loading should be taken from the following table:

Default ASM5015 Actual Horsepower Settings
For 8.6" Dynamometers $HP5015_8$

Vehicle Type	Number of Cylinders				
	3	4	5 & 6	8	> 8
Sedans	7.9	11.4	13.8	16.4	16.0
Station Wagons	8.1	11.7	13.8	16.1	16.1
Mini-vans	10.2	14.1	15.8	17.9	18.2
Pickup Trucks	9.6	13.1	16.4	19.2	21.1
Sport/Utility	10.1	13.4	15.5	19.4	21.1
Full Vans	10.3	13.9	17.7	19.6	20.5

Default ASM5015 Actual Horsepower Settings
For 20" Dynamometers $HP5015_{20}$

Vehicle Type	Number of Cylinders				
	3	4	5 & 6	8	> 8
Sedans	8.1	11.8	14.3	16.9	16.6
Station Wagons	8.3	12.1	14.2	16.6	16.6
Mini-vans	10.4	14.5	16.3	18.5	18.7
Pickup Trucks	9.8	13.4	16.8	19.8	21.7
Sport/Utility	10.5	13.8	15.9	19.9	21.7
Full Vans	10.8	14.4	18.2	20.2	21.1

If the dynamometer speed or torque falls outside the speed or torque tolerance for more than 2 consecutive seconds, or for more than 5 seconds total, the mode timer shall reset to zero and resume timing. The minimum mode length shall be determined as described in §85.2(d)(iii). The maximum mode length shall be 90 seconds elapsed time (mt=90).

During the 10 second period used for the pass decision, the dynamometer speed shall not fall more than 0.5 mph (absolute drop, not cumulative). If the speed at the end of the 10 second period is more than 0.5 mph less than the speed at the start of the 10 second period, testing shall continue until the speed stabilizes enough to meet this criterion.

The ten second emissions window shall be matched to the corresponding vehicle speed trace time window. This shall be performed by subtracting the nominal response time for the analyzers from the mode time to determine the time for the corresponding vehicle speed.

(iii) The pass/fail analysis shall begin after an elapsed time of 25 seconds (mt=25). A pass/fail determination shall be made for the vehicle and the mode shall be terminated as follows:

(A) The vehicle shall pass the ASM5015 mode and the mode shall be immediately terminated if, at any point between an elapsed time of 25 seconds (mt=25) and 90 seconds (mt=90), the 10 second running average measured values for each pollutant are simultaneously less than or equal to the applicable test standards described in §85.1(a).

(B) Pass/Fail determinations may be made at mt=15 seconds if a 50% safety margin in cutpoints is applied from mt=15 to mt=25 seconds, i.e. emissions for all pollutants are simultaneously 50% below the appropriate ASM standards.

(C) The vehicle shall fail the ASM5015 mode and the mode shall be terminated if the requirements of §85.2(d)(1)(iii)(A) are not satisfied by an elapsed time of 90 seconds (mt=90).

(iv) Upon termination of the ASM5015 mode, the vehicle shall immediately begin accelerating to the speed required for the ASM2525 mode. The dynamometer torque shall smoothly transition during the acceleration period and shall automatically reset to the load required for the ASM2525 mode as specified in §85.2(d)(2)(i) once the roll speed specified in §85.2(d)(2)(i) is achieved.

(2) ASM2525 Mode.

(i) The mode timer shall start (mt=0) when the dynamometer speed (and corresponding power) are maintained within 25±1.0 miles per hour for 5 continuous seconds. The dynamometer shall apply the constant torque over the duration of the ASM mode. Torque shall be set to the correct torque necessary to generate the required horsepower at 25.0 mph. If actual torque applied deviates by more than 2% from the target torque for more than two consecutive seconds, the test mode timer shall be set to mt=0.

(ii) The dynamometer power shall be automatically selected from an EPA-supplied or EPA-approved look-up table, based upon the vehicle identification information described in §85.2(a)(1). If a vehicle is not specifically listed in the EPA-approved table, default values from the same table shall be used. If an appropriate default value is not available in the EPA-approved table, ASM loading should be taken from the following table:

Default ASM2525 Actual Horsepower Settings
For 8.6" Dynamometers $HP2525_8$

Vehicle Type	Number of Cylinders				
	3	4	5 & 6	8	> 8
Sedans	6.7	9.5	11.5	13.7	13.3
Station Wagons	6.8	9.7	11.5	13.4	13.3
Mini-vans	8.8	11.7	13.2	14.9	15.3
Pickup Trucks	8.0	10.9	13.6	16.0	17.8
Sport/Utility	8.8	11.2	12.9	16.1	17.8
Full Vans	9.0	11.6	14.7	16.3	17.2

Default ASM2525 Actual Horsepower Settings
For 20" Dynamometers $HP2525_{20}$

Vehicle Type	Number of Cylinders				
	3	4	5 & 6	8	> 8
Sedans	6.9	10.1	12.3	14.5	14.3
Station Wagons	7.0	10.4	12.2	14.2	14.4
Mini-vans	8.9	12.5	14.0	15.9	16.3
Pickup Trucks	8.1	11.4	14.4	16.9	18.8
Sport/Utility	8.9	11.8	13.6	17.1	18.8
Full Vans	9.1	12.5	15.5	17.3	18.3

If the dynamometer speed or torque falls outside the speed or torque tolerance for more than two consecutive seconds, or for more than 5 seconds total, the mode timer shall reset to zero and resume timing. The minimum mode length shall be determined as described in §85.2(d)(2)(iii). The maximum mode length shall be 90 seconds elapsed time (mt=90).

During the 10 second period used for the pass decision, the dynamometer speed shall not fall more than 0.5 mph (absolute drop, not cumulative). If the speed at the end of the 10 second period is more than 0.5 mph less than the speed at the start of the 10 second period, testing shall continue until the speed stabilizes enough to meet this criterion.

(iii) The pass/fail analysis shall begin after an elapsed time of 25 seconds (mt=25). A pass or fail determination shall be made for the vehicle and the mode shall be terminated as follows:

(A) The vehicle shall pass the ASM2525 mode if, at any point between an elapsed time of 25 seconds (mt=25) and 90 seconds (mt=90), the 10-second running average measured values for each pollutant are simultaneously less than or equal to the applicable test standards described in §85.1(a). If the vehicle passed the ASM5015 mode, as described in §85.2(d)(1)(iii), the ASM2525 mode shall be terminated upon obtaining passing scores for all three pollutants. If the vehicle failed the ASM5015 mode, the ASM2525 mode shall continue for an elapsed time of 90 seconds (mt=90).

(B) Pass/Fail determinations may be made at mt=15 seconds if a 50% safety margin in cutpoints is applied from mt=15 to mt=25 seconds, i.e. emissions for all pollutants are 50% below the appropriate ASM standards.

(C) The vehicle shall fail the ASM2525 mode and the mode shall be terminated if the requirements of §85.2(d)(2)(iii)(A) are not satisfied by an elapsed time of 90 seconds (mt=90).

(3) Alternative ASM2525 (ASM5015) Test Procedure

(i) The Alternative ASM2525 (ASM5015) test cycle consists of three modes as depicted qualitatively below. (The same figure may be applied to the Alternative ASM5015 test if one simply recognizes that the y-axis speed value in this case should be 15 mph rather than 25 mph.) Mode 1 is 30 seconds in duration at 25 mph (15 mph), Mode 2 is a short duration speed variation, and Mode 3 is 135 seconds at 25 mph (15 mph).

(ii) The timers for Mode 1 and Mode 3 shall start when the vehicle speed, dynamometer loading and dilution are within the test limits specified above in §85.2(d) (specifically §85.2(d) (1)(i) and §85.2(d)(1)(ii) for the ASM5015 or §85.2(d) (2)(i) and §85.2(d)(2)(ii) for the ASM2525) for 2 continuous seconds and no low flow error is recorded.

(iii) In Mode 1, the vehicle shall pass the test and the test shall be terminated immediately if at any point between 15 and 30 seconds the 10 second running average measured values for each pollutant are simultaneously less than or equal to 50% of the applicable standards.

(iv) If the 10 second running average measured values for each pollutant are not simultaneously less than or equal to 50% of the applicable standards, a speed variation up to 30 mph in 2 seconds, down to 20 mph in 4 seconds and back to 25 mph in 2 seconds shall be performed. During the speed variation there are no acceleration or speed limits; however, the target speeds must be reached.

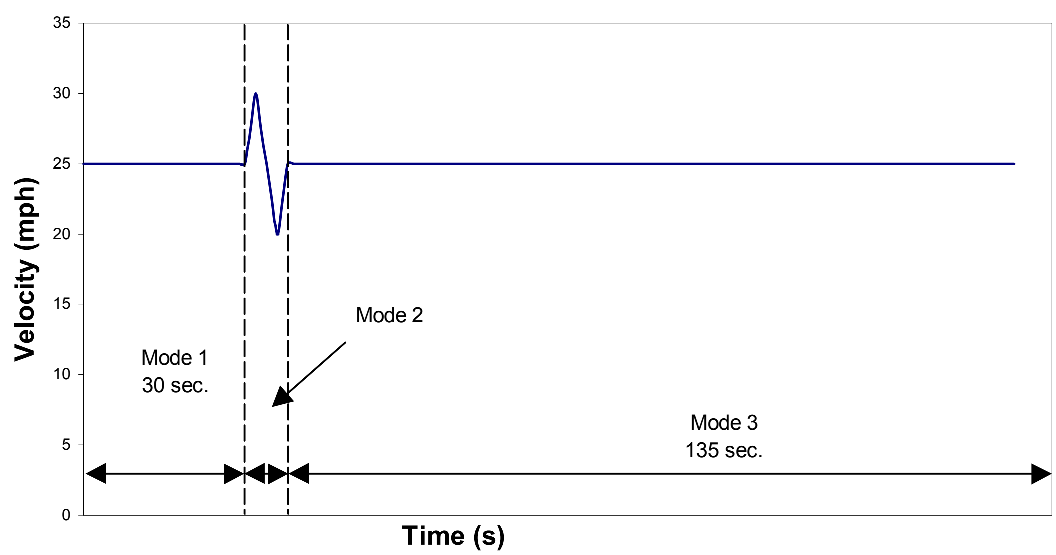
(v) For the ASM5015 test, the speed variation is from 15 mph to 20 mph, down to 10 mph and back to 15 mph in the same time increments outlined above for the ASM2525.

(vi) When the vehicle has returned to 25 mph (15 mph) for 2 seconds, Mode 3 shall begin.

(vii) The vehicle shall pass the test and the test shall be terminated immediately if at any point between 15 and 30 seconds the 10 second running average measured values for each pollutant are simultaneously less than or equal to 50% of the applicable standards.

(viii) Starting at Second 31 in Mode 3, the vehicle shall pass the test and the test shall be terminated immediately if the 10 second running average measured values for each pollutant are simultaneously less than or equal to the applicable standards.

Qualitative Illustration of Alternative ASM Test Procedure



(e) Second Chance Tests.

(1) If the vehicle fails the first-chance test, the test timer shall reset to zero and a second-chance test shall be performed, except as noted below. If the vehicle is not tested within 20 minutes of failing the test it shall be preconditioned by driving the vehicle at the designated test speed and appropriate inertia weight settings for an additional 60 seconds prior to the start of the retest. The second-chance test shall be of the same maximum duration as the first chance test. As each test mode is roughly 90 seconds long, the total maximum test time can vary accordingly depending on whether a one or two mode ASM test is implemented. A retest on only one mode would increase the

total test time to roughly 180 seconds, while performing a retest for each mode on a vehicle that failed both modes would extend the total test time to approximately 360 seconds.

Depending on the length of time it takes to perform the speed wiggle in the Alternative ASM Test Procedure, the maximum time for a single mode should be roughly 170-180 seconds. Retesting a failed vehicle could double this time to 340-360 seconds. Therefore, although the Alternative ASM Test Procedure is designed to improve a vehicle's chances of passing, performing retests using this procedure could double the overall test time versus the Original ASM Test Procedure.

(2) For vehicles that fail one mode of a two mode ASM test, the failed mode may be repeated or extended as described below. An exception to this would be in the case of vehicles already subjected to preconditioning as specified in §85.2(b)(12)(i) or if at least 90 seconds of loaded preconditioning were performed, as specified in §85.2(b)(12)(ii), then the second-chance test may be omitted.

(i) If the vehicle failed only the first mode (ASM5015) of the first chance test, then that mode shall be repeated upon completion of the second mode (ASM2525). The repeated mode shall be performed as described in §85.2(d)(1) except that the provisions of §85.2(d)(1)(iv) shall be omitted. The test will terminate when the mode ends or when the vehicle passes, whichever occurs first.

(ii) If the vehicle is failing only the second mode (ASM2525) of the first chance test, then the second mode shall not end at 90 seconds but shall continue for up to 180 seconds. Mode and test timers shall not reset but rather continue up to 180 seconds. The provisions of §85.2(d)(2) shall continue to apply throughout the 180 second test period.

(iii) If the vehicle failed both modes (ASM5015 and ASM2525) of the first chance test, then the vehicle shall receive a second-chance test for the ASM5015. If the vehicle fails the second-chance ASM5015, then the vehicle shall fail the test. Otherwise, the vehicle shall also receive a second-chance ASM2525.

§85.3 Test Equipment Specifications

(a) Dynamometer Specifications*.

(1) General Requirements

(i) While dynamometer roll diameters may range from 8.5” to 21”, it is preferable that only one diameter of dynamometer roll be used throughout each program whenever possible.

(ii) 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 and axle weights up to 6,000 lbs.

(iii) Dynamometer ASM load horsepower (HP5015 or HP2525) shall be automatically selected based on the vehicle parameters in the test record.

(iv) All dynamometers shall have an identification plate permanently affixed showing at a minimum, the dynamometer manufacturers name, the system provider's name, production date, model number, serial number, dynamometer type, maximum axle weight, maximum HP absorbed, roll diameter, roll width, base inertia weight, and electrical requirements.

(v) The dynamometer shall be designed to meet specifications at an ambient temperature range of 35° to 110°F, and at absolute humidity values representative of the testing location. A wider range of operating temperatures shall be used to reflect local operating conditions if applicable.

(vi) Dynamometers shall be equipped with both torque and speed test points to be used during audits. Test points shall be easily accessed with test clips. The torque signal shall be a DC voltage free of electrical noise. Maximum absorbed torque shall produce between +5 and +10 volts of signal. Maximum motored torque shall produce between -5.0 and -10.0 volts. The speed signal shall consist of a 5 volt pulse signal that can be counted by an external pulse counter. Alternative designs will be considered on a case-by-case basis.

(vii) Alternative dynamometer specifications, designs or error checking may be allowed if proposed by a state and upon a determination by the Administrator that, for the purpose of properly conducting an approved short test, the evidence supporting such deviations show that proper vehicle loading will be applied.

* NOTE: Throughout the specification, whenever dynamometer inertia weight is used in an equation, the units should be referenced as “lbs” and coast-down times should be referenced in “seconds”.

(2) Power Absorption.

(i) Vehicle Loading. The vehicle loading used during the ASM driving cycles shall follow the equation in §85.3(a)(2)(ii) at 15 and 25 mph. Unless otherwise noted, any horsepower displayed during testing shall be expressed as HP*.

(ii) Indicated Horsepower. At constant velocity, the power absorber shall load the vehicle according the following equations:

IHP = TRLHP - PLHP - GTRL

Where: IHP is the dynamometer indicated, or set, horsepower.

TRLHP is the track, or total, horsepower for a particular vehicle.

PLHP is Parasitic Losses Horsepower due to internal dynamometer friction. Parasitic losses are specific to each dynamometer and are a function of speed.

GTRL is Generic Tire/Roll Interface Losses at the specified speed. For two-wheel-drive dynamometers, values may either be taken directly from the EPA-approved Look-up Table, or be calculated according to the procedures outlined in the EPA's IM240 Equipment Specification.

TRLHP, PLHP, GTRL, and therefore IHP, are all expressed as three term polynomials of the type:

$$HP = A*Obmph + B*Obmph^2 + C*Obmph^3$$

Where: HP represents individual expressions relating IHP, TRLHP, PLHP, or GTRL as a function of velocity.

A, B, or C represent horsepower coefficients for the individual expressions relating IHP, TRLHP, PLHP, or GTRL as a function of velocity.

Obmph is the velocity in miles per hour.

Expressions for TRLHP, and GTRL are found in Appendices H and I of the IM240 Guidance

(iii) Range of Power Absorber. The range of the power absorber shall be sufficient to simulate the load required to perform an ASM5015 and an ASM2525 on all light-duty vehicles and light-duty trucks with ETW values up to 7,500 lbs. And

* This is the actual Horsepower value contained in the look-up table for a vehicle being tested (using the ASM5015 or 2525) on a dynamometer with the specified diameter rollers. It is the sum of the Indicated Horsepower and the Parasitic Losses.

5015 tire losses of 3.3 HP. To this end, the power absorber shall be sufficient to absorb a peak load of 33.3 hp at 14 mph for five minutes straight. In addition, the power absorber shall be sufficient to absorb and dissipate energy from continuous cycles consisting of five minutes of 25 horsepower at 14 mph followed by three minutes at rest.

(iv) Power Absorber. Only electric power absorbers shall be used unless alternatives are proposed by the state and approved by the Administrator. The power absorber shall be adjustable in 0.1 hp increments at both 15 MPH and 25 MPH. The accuracy of the power absorber (PAU + parasitic losses) shall be ±0.25 horsepower or ±2% of required power, whichever is greater, in either direction of rotation. For field auditing the accuracy shall be ±0.5 horsepower.

(v) Accuracy Over the Operating Range. The dynamometer's accuracy when warm shall not deviate more than ±0.5 horsepower over the full ambient operating range of 35°F to 110°F. This may be accomplished by intrinsic design or by software correction techniques. At any constant temperature, the dynamometer shall have an accuracy of ±0.5 horsepower within 15 seconds from the time the rolls start turning, and shall have an accuracy of ±0.25 horsepower within 30 seconds from the time the rolls start turning. For temperatures outside the specified range, the dynamometer shall provide correction or proceed with a manufacturer warm-up sequence until full warm condition has been reached.

(3) Inertia.

(i) Test Inertia. The dynamometer shall be equipped with mechanical flywheel(s) or with full inertia simulation providing an inertia weight of 2000 pounds ±40 pounds. Any deviation from the 2000 pound base inertia shall be quantified and the coast-down time shall be corrected accordingly.

For all-wheel-drive dynamometers that may be operated in either two- or four-wheel-drive modes, the inertia in two-wheel-drive mode must comply with the above requirements. The inertia in four-wheel-drive mode may be different, however it shall be quantified to within 10 lbs.

The actual test inertia weight shall be marked on the ID plate required in §85.3(a)(1)(iv). In the case of all-wheel-drive dynamometers, the test inertia must be displayed for both two- and all-wheel-drive operation.

(ii) Inertia/Inertia Simulation. The dynamometer shall be capable of conducting, at a minimum, diagnostic level transient inertia simulations with an acceleration rate between 0 and 3.3 miles per hour per second with a minimum load (power) of 25 horsepower at 14 mph over the inertia weight range of 2000 pounds to 6000 pounds. For the diagnostic level inertia simulation, the 25 horsepower criterion is a requirement on acceleration only, while for the full inertia simulation option, the requirement is for both acceleration and deceleration. Mechanical inertia simulation shall be provided in 500 pound increments; electric inertia simulation shall be provided in 1 pound increments. Any deviation from the stated inertia shall be quantified and the inertia simulation shall be corrected accordingly. Mechanical or electrical inertia simulation, or a combination of both, may be used, subject to review and approval by the state.

(A) Diagnostic Level Simulation.

1. System Response. The torque response to a step change shall be at least 90% of the requested change within 300 milliseconds.

2. Simulation Error. An inertia simulation error (ISE) shall be continuously calculated any time the actual dynamometer speed is between 10 MPH and 60 MPH. The ISE shall be calculated by the equation in §85.3(a)(3)(ii)(C), and shall not exceed 3% of the inertia weight selected (IW_s) for the vehicle under test.

(B) Full Inertia Simulation. (Recommended Option)

1. System Response. The torque response to a step change shall be at least 90% of the requested change within 300 milliseconds. Torque response shall settle to within 2% of the requested change within 600 milliseconds.

2. Simulation Error. Horsepower simulation error (HPSE) shall be continuously calculated any time the dynamometer speed is greater than 5 mph. The HPSE is defined as the average difference between the desired power (DP) and the achieved power (AP) in 10 measurements taken at 0.5-second sequential intervals over the previous 5 seconds, divided by the total power (TP = inertia plus road load). However, if augmented braking is applied or the desired PAU power is less than or equal to zero* during any 0.5-second measurement, then the difference between the desired and achieved power for that 0.5-second measurement shall be set to 0. Values set to be 0 shall be used in the 5-second moving averages. If TP is less than 5HP over the 5-second period, set TP to 5HP.

(C) Horsepower Simulation Error Calculation.

$$\text{HPSE} = \sum_{i}^{i-10}(DP - AP) \Big/ \sum_{i}^{i-10} TP$$

* This shall only apply to eddy current dynamometers, not full electric dynamometers.

Where:
- i - current 0.5-second interval, starting at second 5
- DP -desired power (inertia plus road load minus GTRL and PLHP)
- AP - achieved power (measured at the load cell)
- TP - total power (inertia plus road load)

A violation occurs if HPSE is greater than ±0.25%.

(4) Parasitic Losses.

(i) The parasitic losses (PLHP) in each dynamometer system (including but not limited to windage, bearing friction, and system drive friction) shall be characterized at 15 and 25 mph upon initial acceptance, and during each dynamometer calibration. The parasitic power losses shall be determined as indicated in §85.4(b)(2).

~~(ii)~~ For all-wheel-drive dynamometers that can be operated in either two or four-wheel-drive modes, parasitic losses must be characterized in both modes. Software controlling the dynamometer must automatically adjust programmed parasitic losses depending upon the mode in which the dynamometer is operating.

(5) Rolls.

(i) Size and Type. The dynamometer shall be equipped with twin rolls. The rolls shall be coupled side to side. In addition, the front and rear rolls shall be coupled. The dynamometer roll diameter shall be between 8.5 and 21.0 inches. The spacing between the roll centers shall comply with the equation in §85.3(a)(5)(iii). The dynamometer rolls shall accommodate an inside track width of 30 inches and an outside track width of at least 100 inches.

(ii) Roll Installation. Rolls shall be installed in the floor such that vehicles will be be reasonably level when tested. The system shall be designed and installed such that ±8 degrees of level is achieved for vehicles having an 86” wheelbase and 27” outer diameter tires; an 89” wheelbase and 18” outer diameter tires; and a 170” wheelbase with 33” outer diameter tires. Either in-floor or above-ground installations are acceptable providing they meet these criteria.

(iii) Roll Spacing. The spacing between the roll centers shall comply with the following equation to within +0.5 inches and -0.25 inches.

Roll Spacing = (24.375 + D) * Sin 31.5

Where: Roll Spacing is the distance between the roll centerlines in inches.
D= Roll diameter in inches

(iv) Roll Surface. The surface finish and hardness shall be such that tire slippage is minimized when testing vehicles using the inertia weight and horsepower settings found in the EPA I/M Look-up Table while following the driving schedule, and that tire wear and noise are minimized. Knurled roll surfaces are acceptable*.

(v) Vehicle Lift. A vehicle lift system located between the dynamometer rolls shall be provided to facilitate drive axle positioning and vehicle egress from the dynamometer.

(vi) Vehicle Restraint System. The system shall include a system of safely restraining the forward and side-to-side motion of front wheel drive vehicles, and the forward motion of rear wheel drive vehicles during the driving schedule, while allowing unobstructed ingress and egress from the dynamometer.

(6) Load Measuring Device

(i) Torque Measurement. The dynamometer shall have a torque measurement system accurate to within ±2% of full scale.

(ii) Dead Weights. Dead weights used to calibrate a torque meter or load measuring device shall be traceable to NIST and be accurate to within ±0.5%. Dead weights traceable to standards other than NIST may be used upon approval of the Administrator.

(iii) Dynamic Calibrations. Designs using an F = MA method for calibrating the load cell are also acceptable; however, systems using such dynamic calibrations must provide an external means of accurately determining base inertia or performing load cell calibrations.

(7) All-Wheel-Drive-Dynamometers.

(i) Design. The dynamometer shall meet the requirements for two-wheel-drive vehicles and be capable of testing traction control and all-wheel-drive vehicles in a safe manner without damaging the vehicle.

(ii) Wheelbase. The all-wheel-drive dynamometer shall be capable of testing vehicles having wheelbases ranging from 84 to 125 inches. The separation between the front and rear dynamometer rolls shall be automatically adjustable in increments of 1.00” or less and shall be accurate to ±0.25” of the selected vehicle wheelbase. Once a vehicle is positioned on the dynamometer, the

* It should be noted that knurlling or altering the surface of the dynamometer will effect the GTRL coefficients. However, at this time it is believed that the impact such alterations may have will be minimal and not affect emissions measurements.

dynamometer must allow the vehicle to be centered on the dynamometer, including fine tuning the roll separation as necessary to meet the actual wheelbase of the vehicle within 0.1". After the roll separation matches the vehicle, the dynamometer must automatically lock the roll separation prior to the beginning of loaded testing. The roll separation lock must be sufficient to maintain the roll separation to within 0.25" of the vehicle wheelbase when 1000 lbs of force is applied to either compress or extend the dynamometer roll separation.

(iii) Speed Synchronization. Front and rear rolls shall maintain speed synchronization within ±0.1 mph during steady-state operation. During transient speed operation, secondary roll speed must be maintained within ±0.1 mph or 1% of the primary roll speed, whichever is greater. Since many traction control vehicles will not be equipped with all-wheel drive, the secondary rolls must have sufficient power to drive and maintain speed for the non-drive wheels without assistance from the vehicle.

(iv) Bi-directionality. Dynamometers in which one set of rolls is considered primary (i.e., drive wheels for non-all-wheel-drive vehicles must be place on one set) must be bi-directional. This will allow both front- and rear-wheel-drive vehicles to be tested in all-wheel-drive mode.

(v) Disengageable Secondary Rolls. Dynamometers may be configured so that secondary rolls may be automatically disengaged when all-wheel-drive testing is not required. If the secondary rolls are disengaged, the system shall automatically compensate for the change in parasitic losses and base inertia as well and the change in generic tire roll losses.

(vi) Base inertia. All-wheel-drive dynamometers that can be operated in either two- or all-wheel-drive modes must account for changes in base inertia resulting from the two different configurations.

(8) Other Requirements.

(i) Vehicle Speed. The measurement of roll speed shall be accurate within 0.1 mph over the full operating range. The dynamometer shall accommodate vehicle speeds of up to 60 mph.

(ii) Vehicle Restraint. In §85.2(b)(10).

(iii) Vehicle Cooling. In §85.2(c)(6).

(iv) Four-Wheel Drive. If used, four-wheel drive dynamometers shall insure the application of correct vehicle loading as defined in §85.3(a)(2), shall not damage the four wheel drive system of the vehicle, and shall accommodate vehicles equipped with anti-lock brakes and/or traction control. Front and rear wheel rolls shall maintain speed synchronization within 0.2 mph.

(v) Installation. In §85.3(a)(5)(ii).

(vi) Augmented Braking. Dynamometers shall apply augmented braking on major decelerations during transient drive cycles, if such cycles are used in the program. The dynamometer software shall provide a signal output to inform the operator when augmented braking is activated. Augmented braking shall be actuated only when the negative force applied by the vehicle at the roll surface is greater than 110 lbs. Augmented braking shall be applied so that at least 50% of the braking force beyond 110 lbs required to meet the deceleration requirements of the drive trace is absorbed by the dynamometer.

(b) Emission Sampling System.

(1) The sampling system shall be designed to insure durable, leak free operation and be easily maintained. Materials that are in contact with the gases sampled shall not contaminate or change the character of the gases to be analyzed, including gases from vehicles not fueled by gasoline (except diesels). The system shall be designed to be corrosion-resistant and be able to withstand typical vehicle exhaust temperatures when the vehicle is driven through the ASM test cycle for the maximum test length described in §85.2(e).

(2) The sampling system shall draw exhaust gas from the vehicle, shall remove particulate matter and aerosols from the sampled gas, shall drain condensed water from the sample if necessary, and shall deliver the resultant gas sample to the analyzers/sensors for analysis and then deliver the analyzed sample directly outside the building. The sampling system shall, at a minimum, consist of a tailpipe probe, flexible sample line, water removal system, a particulate trap, sample pump, and flow control components.

(3) Sample Probe.

(i) Insertion. The sample probe shall allow at least a 16 inch insertion depth of the sample probe into the vehicle's exhaust. In addition, the probe shall be inserted at least 10 inches into the vehicle's exhaust. Use of a tailpipe extension is permitted as long as the extension does not change the exhaust back pressure by more than ±1.0 inch of water pressure.

(ii) Retention. The probe shall incorporate a positive means of retention to prevent it from slipping out of the tailpipe during use. High through-put test systems may use alternative means to insure probe retention.

(iii) Flexibility. The probe shall be designed so that the tip extends 16 inches into the tailpipe. The probe tip shall be shielded so that debris is not scooped up by the probe when it is inserted into the tailpipe. High through-put test systems may use alternative means to insure adequate probe insertion.

(iv) Probe Tip. Probe tips shall be designed and constructed to prevent sample dilution.

(v) 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 they shall not taint the sample). Acceptable materials include stainless steel, Teflon, silicon rubber, and Tedlar. Dissimilar metals with thermal expansion factors of more than 5% shall not be used in either the construction of probes or connectors. The sample probe shall be constructed of stainless steel or other non-corrosive, non-reactive material which can withstand exhaust gas temperatures at the probe tip of up to 1,100°F for 10 minutes.

(vi) System Hoses and Connections. Hoses and all other sample handling components must be constructed of, or plated with a non-reactive, non-corrosive, high temperature material which will not affect, or be affected by, the exhaust constituents and tracer gases.

(vii) Dual Exhaust. The sample system shall provide for the testing of dual exhaust equipped vehicles. When testing a vehicle with functional dual exhaust pipes, a dual sample probe of a design certified by the analyzer manufacturer to provide equal flow in each leg shall be used. The equal flow requirement is considered to be met if the flow rate in each leg of the probe has been measured under two sample pump flow rates (the normal rate and a rate equal to the onset of low flow), and if the flow rates in each of the legs are found to be equal to each other (within 15% of the flow rate in the leg having lower flow).

(4) Particulate Filter. The particulate filter shall be capable of trapping 97% of all particulate and aerosols 5 microns or larger. The filter element shall not absorb or adsorb hydrocarbons. The filter housing shall be transparent or translucent to allow the operator to observe the filter element's condition without removing the housing. The filter element shall be easily replaceable and shall provide for reliable sealing after filter element changes.

(5) Water Trap. The water trap shall be sized to remove exhaust sample water from vehicles fueled with gasoline, propane, compressed natural gas, reformulated gasoline, alcohol blends or neat, and oxygenated fuels. The filter element, bowl and housing shall be inert to these fuels as well as to the exhaust gases from vehicles burning these fuels. The condensed water shall be drained from the water trap's bowl either continuously or automatically on a periodic basis such that the following performance requirement is maintained. Sufficient water shall be trapped, regardless of fuel, to prevent condensation in the sample system or in the optical bench's sample cell.

(6) Low Flow Indication. The analyzer shall lock out official testing when the sample flow is below the acceptable level. The sampling system shall be equipped with a flow meter (or equivalent) that shall indicate sample flow degradation when measurement error exceeds 3% of the gas value used for checking, or causes the system response time to exceed 13 seconds to 90 percent of a step change in input (excluding NO), whichever is less. Alternatively, the sample vacuum may be continuously monitored to detect a low flow condition.

(7) Exhaust Ventilation System. The high quantities of vehicle emissions generated during loaded mode testing shall be properly vented to prevent buildup of hazardous concentrations of HC, CO, CO_2 and NOx. Sufficient ventilation shall be provided in

the station to maintain HC, CO, CO_2 and NO levels below recommended Occupational Safety and Health Association (OSHA) standards*.

(i) The ventilation system shall discharge the vehicle exhaust outside the building.

(ii) The flow of the exhaust collection system shall not cause dilution of the exhaust at the sample point in the probe.

(iii) The flow of the exhaust collection system shall not cause a change of more than ±1.0 inches of water pressure in the vehicle's exhaust system at the exhaust system outlet.

(c) Analytical Instruments.

(1) General Requirements.

(i) Measured Gases. The analyzer system shall consist of analyzers for HC, CO, NO, and CO_2, (O_2 optional). It is recommended that the system provide digital displays for exhaust concentrations of HC, CO, NO, and CO_2, as well as for vehicle speed; however, it is recognized that some BAR97 systems do not provide these features.

(ii) Emission Accuracy. The system shall ensure that the analytical system provides an accurate accounting of the actual exhaust emissions produced during the test, taking into consideration the individual channel accuracy, repeatability, interference effects, sample transport times, and analyzer response times.

(iii) Sample Rate. The analyzer shall be capable of measuring exhaust concentrations of the gases specified in §85.3(c)(1)(i) at a minimum rate of once per second.

(iv) Alternative Equipment. Alternative analytic equipment specification, materials, designs, or detection methods may be allowed if proposed by a state and upon a determination by the Administrator, that for the purpose of properly conducting a test, the evidence supporting such deviations will not significantly affect the proper measurement of emissions.

(2) Performance Requirements.

(i) Temperature Operating Range. The analyzer system and all associated hardware shall operate within the performance specifications described in §85.3(c)(3) at ambient air temperatures ranging from 35°F to 110°F. Analyzers shall be designed so that adequate air flow is provided around critical components to prevent overheating (and automatic shutdown) and to prevent the condensation of water vapor which could reduce the reliability and durability of

* The following limits may be found in 29 CFR 1910.1000 Table Z-1. CO 50 ppm; CO_2 5000 ppm; NO_2 5 ppm; n-Hexane 500 ppm; Propane 1000 ppm.

the analyzer. The analyzer system shall otherwise include necessary features to keep the sampling system within the specified range.

(ii) Humidity Operating Range. The analyzer system and all associated hardware shall operate within the performance specifications described in §85.3(c)(3) at a minimum of 85% relative humidity throughout the required temperature range.

(iii) Interference Effects. The interference effects for non-interest gases shall not exceed ±4 ppm for hydrocarbons, ±0.02% for carbon monoxide, ±0.20% for carbon dioxide, and ±20 ppm for nitric oxide when using the procedure specified in §85.4(d)(5)(iv). Corrections for collision-broadening effects of combined high CO and CO_2 concentrations shall be taken into account in developing the factory calibration curves, and are included in the accuracy specifications.

(iv) Barometric Pressure Compensation. Barometric pressure compensation shall be provided. Compensation shall be made for elevations up to 6000 feet (above mean sea level). At any given altitude and ambient conditions specified in §85.3(c)(2)(i) and (ii), errors due to barometric pressure changes of ±2 inches of mercury shall not exceed the accuracy limits specified in §85.3(c)(3).

(iv) System Lockout During Warm-up. Functional operation of the gas sampling unit shall remain disabled through a system lockout until the instrument meets stability and warm-up requirements. The instrument shall be considered "warm" when the zero and span readings for HC, CO, NO, and CO_2 have stabilized, within the accuracy values specified in §85.3(c)(3) for five minutes without adjustment.

(v) Zero Drift Lockout. If zero or span drift cause the optical bench signal levels to move beyond the adjustment range of the analyzer, the system shall be locked out from testing.

(vi) Electromagnetic Isolation and Interference. Electromagnetic signals found in an automotive service environment shall not cause malfunctions or changes in the accuracy in the electronics of the analyzer system. The instrument design shall ensure that readings do not vary as a result of electromagnetic radiation and induction devices normally found in the automotive service environment, including high energy vehicle ignition systems, radio frequency transmission radiation sources, and building electrical systems.

(vii) Vibration and Shock Protection. System operation shall be unaffected by the vibration and shock encountered under the normal operating conditions encountered in an automotive service environment.

(viii) Propane Equivalency Factor. The nominal PEF range shall be between 0.490 and 0.540. For each audit/calibration point, the nominal PEF shall be conveniently displayed for the quality assurance inspector and other authorized personnel. Ideally, the PEF shall appear on the monitor in conjunction with the HC reading during any audit or at the operator's request.

If an optical bench must be replaced in the field, any external labels shall be changed to correspond to the nominal PEF of the new bench. The analyzer shall incorporate an algorithm relating PEF to HC concentration. Corrections shall be made automatically. The corrected PEF value may cover the range of 0.470 to 0.560

(ix) System Response Requirements. The response time from the probe to the display for HC, CO, and CO_2 analyzers shall not exceed 8 seconds for 90% of a step change in input, nor shall it exceed 12 seconds to 95% of a step change in input. The response time for a step change in O_2 from 20.9% O_2 to 0.1% O_2 shall be no longer than 40 seconds. For NO analyzers, the response time shall not exceed 12 seconds for 90% of a step change in input. The response time for a step change in NO from a stabilized reading to 10% of that reading shall be no longer than 12 seconds.

(3) Detection Methods, Instrument Ranges, Accuracy, and Repeatability.

(i) Hydrocarbon Analysis. Hydrocarbon analysis shall be determined by non-dispersive infrared (NDIR) analyzer. The analyzer shall cover at least the range of 0 ppm HC to 9999 ppm HC, where ppm HC is parts per million of hydrocarbon volume as hexane. The accuracy of the instrument from 0-2000 ppm HC shall be ±3% of point or 4 ppm C6, whichever is greater. The accuracy of the instrument between 2001 ppm HC and 5000 ppm HC shall be at least ±5% of point and the accuracy of the instrument between 5001 ppm HC and 9999 ppm HC shall be at least ±10% of point. The instrument shall comply with the quality control specifications in §85.4(d).

(ii) Carbon Monoxide Analysis. Carbon monoxide analysis shall be determined by non-dispersive infrared (NDIR) analyzer. The analyzer shall cover at least the range of 0.00 % CO to 14.00% CO, where % CO is % volume CO. The accuracy of the instrument between 0.01% and 10.00% CO shall be ±3% of point or 0.02% CO, whichever is greater. The accuracy of the instrument between 10.01% and 14.00% shall be at least ±5% of point. The instrument shall comply with the quality control specifications in §85.4(d).

(iii) Carbon Dioxide Analysis. Carbon dioxide analysis shall be determined by non-dispersive infrared (NDIR) analyzer. The analyzer shall cover at least the range of 0.0 % CO_2 to 18.0% CO_2. The accuracy of the instrument between 0.01% and 16.00% CO_2 shall be ±3% of point or 0.3% CO_2, whichever is greater. The accuracy of the instrument between 16.01% and 18.00% shall be at least ±5% of point. The instrument shall comply with the quality control specifications in §85.4(d).

(iv) Nitric Oxide Analysis. The analyzer shall cover at least the range of 0 ppm NO to 5000 ppm NO, where ppm NO is parts per million nitric oxide. The accuracy of the instrument between 0 and 4000 ppm shall be at least ±4% of point or 25 ppm NO, whichever is greater. The accuracy of the instrument between 4001 and 5000 ppm shall be at least ±8% of point. The instrument shall comply with the quality control specifications in §85.4(d).

(v) Oxygen Analysis. (optional) If an oxygen analyzer is included, the analyzer shall cover at least the range of 0.0% O_2 to 25.0% O_2. The accuracy of the instrument over this range shall be at least 5% of point or ±0.1% O_2, whichever is greater. The instrument shall comply with the quality control specifications in §85.4(d).

(vi) Repeatability. The repeatability for the HC analyzer in the range of 0-1400 ppm HC shall be 2% of point or 3 ppm HC absolute, whichever is greater. In the range of 1400-2000 ppm HC, the repeatability shall be 3% of point. The repeatability for the CO analyzer in the range of 0-7.00% CO shall be 2% of point or 0.02% CO absolute, whichever is greater. In the range of 7.00% to 10.00% CO, the repeatability shall be 3% of point. The repeatability for the CO_2 analyzer in the range of 0-10.0% CO_2 shall be 2% of point or 0.1% CO_2 absolute, whichever is greater. In the range of 10.0% to 16.0% CO_2, the repeatability shall be 3% of point. The repeatability of the NO analyzer shall be 3% of point or 20 ppm NO, whichever is greater. The repeatability of the O_2 analyzer shall be 3% of point or 0.1% O_2, whichever is greater.

(vii) Rounding Rule. Rounding beyond the decimal places shown in §85.3(c)(3) shall follow the standard mathematical practice of going to the next higher number for any numerical value of five or more. This shall also hold true for pass/fail decisions. For example, if 2.00% CO passes and 2.01% CO fails, and the reading is 2.0049%, the value shall be rounded down and the decision shall be a pass. If the reading is 2.0050, the value shall be rounded up and the decision shall be a fail. The value displayed and printed on the test report shall be consistent with the value used for the pass/fail decision.

(4) Ambient Conditions. The current relative humidity, dry-bulb temperature, and barometric pressure shall be measured and recorded prior to the start of every inspection in order to calculate K_h (nitric oxide correction factor §85.1(b)(1)(vi)).

(i) Relative Humidity. The relative humidity measurement device shall cover the range from 5% to 95% RH, between 35°F - 110°F, with a minimum accuracy of ±3% RH. Wet bulb thermometers shall not be used.

(ii) Dry-bulb Temperature. The dry-bulb temperature device shall cover the range from 0°F - 140°F with a minimum accuracy of 3°F.

(iii) Barometric Pressure. The barometric pressure measurement device shall cover the range from 610 mm Hg - 810 mm Hg absolute (24-32 inches), and 35°F - 110°F, with a minimum accuracy of ±3% of point or better.

(5) Engine Speed Detection. The analyzer shall utilize a tachometer capable of detecting engine speed in revolutions per minute (RPM) with a 0.5 second response time and an accuracy of ±3% of the true RPM. On vehicles equipped with onboard diagnostic (OBD) systems, it is recommended that the engine speed be taken by connecting to the SAE standardized OBD link on 1996 and newer vehicles. RPM readings shall be recorded on a second-by-second basis for the 10 second period upon which the pass/fail decision is based.

(6) OBD Fault Code Retrieval. Starting in 2001 the system shall include the hardware and software necessary to access the onboard computer systems on 1996 and newer vehicles, determine OBD readiness, and recover stored fault codes using the SAE standardized link.

(d) Automated Test Process Software and Displays.

(1) Software. The testing process, data collection, and quality control features of the analyzer system shall be automated to the greatest degree possible. The software shall automatically select the emission standards and set the vehicle load based on an EPA-provided or approved look-up table. Vehicle identification information shall be derived from a database accessed over a real-time data system to a host computer system. Entry of license plate and all or part of the VIN shall be sufficient to access the vehicle record. Provision shall be made for manual entry of data for vehicles not in the host computer system. Alternative methods for matching test records to the appropriate vehicle and ensuring that the vehicle is tested using the proper parameters may be used if approved by the Administrator.

(2) Test and mode timers. The analyzer shall be capable of simultaneously determining the amount of time elapsed in a test (overall test time), and in a mode within that test (mode time).

(3) Clocks and Timers. The clock used to check the coast-down time shall be accurate to within 0.1% of reading between 0.5 and 100 seconds, with a resolution of 0.001 seconds. The test mode timers used shall be accurate to within 0.1% of reading between 10 and 1000 seconds with a resolution of 0.1 seconds.

(4) Driver's Aid. The system shall be equipped with a driver's aid that shall be clearly visible to the driver as the test is performed. The aid shall continuously display the required speed, the number of seconds into the test mode, the driver's actual speed/time performance (a display showing the deviation between set-point and actual driving trace), engine RPM, the use of augmented braking, and necessary prompts and alerts. It is recommended that an analog speed display be used as this has been demonstrated to improve a driver's ability to maintain the ±1.0 mph tolerance. The driver's aid shall also be capable of displaying test and equipment status and other messages as required. Dynamic information being displayed shall be refreshed at a minimum rate of twice per second. Emissions values shall not be displayed during official testing.

(5) Minimum Analyzer Display Resolution. The analyzer electronics shall have sufficient resolution to achieve the following:

HC	1	ppm HC as hexane
NO	1	ppm NO
CO	0.01	% CO
CO_2	0.1	% CO_2
O2	0.1	% O2 (optional)
RPM	10	RPM
Speed	0.1	mph

Load	0.1	hp
Relative Humidity	1	% RH
Dry Bulb Temperature	1	˚F
Barometric Pressure	1	mm Hg

§85.4 Quality Control Requirements

(a) General Requirements

(1) Minimums. The frequency and standards for quality control specified here are minimum requirements, unless modified as specified in §85.4(a)(2). Greater frequency or tighter standards may be used as needed.

(2) Statistical Process Control. Reducing the frequency of the quality control checks, modifying the procedure or specification, or eliminating the quality control checks altogether may be allowed if the state demonstrates and the Administrator determines, for the purpose of properly conducting an approved short test, that sufficient Statistical Process Control (SPC) data exist to make a determination, that the SPC data support such action, and that taking such action will not significantly reduce the quality of the emissions 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.

(b) Dynamometer

(1) Coast Down Check.

(i) The calibration of each dynamometer shall be automatically checked every 72 hours in low volume stations (less than 4000 tests per year) and daily in high volume stations by a dynamometer coast-down procedure equivalent to 40 CFR §86.118-78 (for reference see National Vehicle and Fuel Emission Laboratory's Testing Services Division test procedure TP-302A and TP-202) between the speeds of 30-20 mph if the ASM2525 is used and 20-10 mph if the ASM5015 is used. All rotating dynamometer components shall be included in the coast-down check. Speed windows smaller than ± 5 mph may be used provided that they show the same calibration capabilities.

(ii) The dynamometer calibration shall be checked at two random horsepower settings for each speed range using the 2000 lb. test inertia. The two random horsepower settings shall be between 8.0 and 18.0 horsepower. The random selection shall be evenly distributed throughout the 8 to 18 HP range. A shunt resistor for a load cell performance check shall not be used.

(iii) The coast-down procedure shall use a vehicle-off-dynamometer type method or equivalent. Using a vehicle to bring the dynamometer up to speed and removing the vehicle before the coast-down shall not be permitted. If either the measured 30-20 mph coast-down time or 20-10 mph coast-down time is outside the window bounded by the Calculated Coast-Down Time (CCDT) (seconds) ± 6% then it shall be locked out for official testing purposes until recalibration allows a passing value.

If the dynamometer fails a coast-down check, a parasitic loss determination shall be required and performed automatically.

(A) Randomly select an IHP_{2525} value that is between 8.0 hp and 18.0 hp and set dynamometer PAU to this value.

Coast-down dynamometer from 30-20 mph.

$$CCDT_{@25mph} = \frac{\frac{0.5 * DIW}{32.2} * (V_{30}^2 - V_{20}^2)}{550 * (IHP_{2525} + PLHP_{25})}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{30} = Velocity in feet/sec at 30 mph.

V_{20} = Velocity in feet/sec at 20 mph.

IHP_{2525} = Randomly selected ASM2525 indicated horsepower.

$PLHP_{25}$ = Parasitic Horsepower for specific dynamometer at 25 mph.

(B) Randomly select an IHP_{5015} value that is between 8.0 hp and 18.0 hp and set dynamometer PAU to this value.

Coast-down dynamometer from 20-10 mph.

$$CCDT_{@15mph} = \frac{\frac{0.5 * DIW}{32.2} * (V_{20}^2 - V_{10}^2)}{550 * (IHP_{5015} + PLHP_{15})}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{20} = Velocity in feet/sec at 20 mph.

V_{10} = Velocity in feet/sec at 10 mph.

IHP_{5015} = Randomly selected ASM5015 indicated horsepower.

$PLHP_{15}$ = Parasitic Horsepower for specific dynamometer at 15 mph.

(2) Parasitic Value Calculations. Parasitic losses should be measured any time service is performed on a dynamometer, as the first step in diagnosing a dynamometer's inability to pass a coast-down, or if the load measuring device is re-calibrated.

(i) Parasitic losses shall be calculated using the following equations at 25 and 15 mph whenever a coast-down check is performed, except the indicated horsepower (IHP) shall be set to zero for these tests. -Parasitic losses shall be determined using the equations listed below. After new parasitic values are calculated, the coast-down check procedure contained in §85.4(b)(1) must be passed before the dynamometer can be returned to service.

(ii) Parasitic losses at 25 mph for a dynamometer with specified diameter rollers.

$$PLHP_{25} = \frac{\frac{0.5 * DIW}{32.2} * (V_{30}^2 - V_{20}^2)}{550 * (ACDT)}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{30} = Velocity in feet/sec at 30 mph.

V_{20} = Velocity in feet/sec at 20 mph.

ACDT = Actual coast-down time required for dynamometer to coast from 30 to 20 mph.

(iii) Parasitic losses at 15 mph for a dynamometer with specified diameter rollers.

$$PLHP_{15} = \frac{\frac{0.5 * DIW}{32.2} * (V_{20}^2 - V_{10}^2)}{550 * (ACDT)}$$

Where:

DIW = Dynamometer Inertia Weight. Total "inertia" weight of all rotating components in dynamometer.

V_{20} = Velocity in feet/sec at 20 mph.

V_{10} = Velocity in feet/sec at 10 mph.

ACDT = Actual coast-down time required for dynamometer to coast from 20 to 10 mph.

(3) Roll Speed. There is no need to perform roll speed checks on a regular basis, providing the coast-down procedures are being performed and adhered to. This is because dynamometers will not be able to pass the coast-down test with erroneous speed readings, especially when the load is changed from coast-down to coast-down.

(4) Load Measuring Device. If the dynamometer fails a coast-down check immediately after performing a parasitic loss determination, then the dynamometer load measuring device may be malfunctioning or out of calibration. In this case, or in the case of the load measuring system being serviced, the load-measuring device shall be checked using a dead-weight method or an equivalent procedure proposed by the state and approved by the Administrator. The check shall cover at least three points over the range of loads used for vehicle testing. Dead weights shall be traceable to the National Institute of Standards (NIST) and shall be accurate to within ±0.1%. Dead weights traceable to standards other than NIST may be used upon approval of the Administrator. The dynamometer shall provide an automatic load measuring device calibration and verification feature.

(5) Certification Testing.

(i) Load Cell Verification (if equipped). This test confirms the proper operation of the dynamometer load cell and associated systems. Weights in the proper range shall be supplied by the system supplier. Weights shall be NIST traceable to 0.1% of point. Dead weights traceable to standards other than NIST may be used upon approval of the Administrator.

(A) Calibrate the load cell according to the manufacturer's direction.

(B) Using a dead weight method, load the test cell to 20%, 40%, 60%, and 80% (in ascending order) of the range used for ASM testing. Record the readings for each weight. Remove the weights in the same steps (descending order) and record the results.

(C) Perform steps A through B two more times (total of three). Calculate the average value for each weight. Multiply each average weight from E by the length of the torque arm.

(D) *Acceptance Criteria:* The difference for each reading from the weight shall not exceed 1% of full scale.

(ii) Speedometer Verification. This test confirms the accuracy of the dynamometer's speedometer.

(A) Measure the dynamometer roll diameter to within ±0.01 inch. This may be accomplished using a PI tape. If the dynamometer is able to motor to a constant speed, set the dynamometer speed to 15 mph. If the dynamometer does not have the ability to motor at constant speeds, place a vehicle on the dynamometer and drive the vehicle at a constant speed as close to 15 mph as possible. Independently measure and record dynamometer roll rotational frequency using a frequency counting device such as a strobe tachometer. Mathematically convert the roll diameter to circumference and multiply by the rotational frequency to obtain linear speed. Compare this speed to the speed measured by the test system. Repeat at 25 mph.

(B) *Acceptance Criteria:* The difference for each reading from set dynamometer speed shall not exceed 0.1 mph.

(iii) Parasitics Verification. Parasitic losses shall be verified at 25 and 15 mph using the procedure in §85.4(b)(2), using time data from a system independent source (e.g. stopwatch) and speed data from the system. The indicated horsepower (IHP) shall be set to zero for these tests.

(A) *Acceptance Criteria:* The difference between the externally calculated value and the machine calculated value shall not exceed 10% of the independently measured value.

(iv) Verify Coast-Down. The coast-down procedure shall use a vehicle off-dynamometer type method or equivalent. Using a vehicle to bring the dynamometer up to speed and removing the vehicle before the coast-down shall not be permitted.

(A) To verify the coast-downs at 25 mph, use the procedure and equations described in §85.4(b)(2)(ii).

(B) To verify the coast-downs at 15 mph, use the procedure and equations described in §85.4(b)(2)(iii).

(C) *Acceptance Criteria:* The measured 30-20 mph coast-down time and the 20-10 mph coast-down time must be inside the window bounded by CCDT (seconds) ± 6% at both speeds.

(6) Field Auditing.

(i) Frequency. Field audits should be performed on each dynamometer at least once per year (A) Calibrate the load cell according to the manufacturer's direction.

(ii) Perform coast-down check to verify system does not self diagnose any problems. Correct any problems as necessary.

(iii) Dynamometer load verification may be performed either with an existing dynamometer tester or by reading voltage directly from the dynamometer load cell. If an existing dynamometer tester is used, follow the directions provided by the tester manufacturer. If voltage measurement is used, follow the directions below:

(A) Determine the ratio for converting load cell voltage into dynamometer load.

(B) Test a known vehicle on the ASM test while measuring voltage at the load cell.

(C) Determine vehicle load by plugging known values into the loading equation found in §85.3.a.2.ii. Determine vehicle load by plugging known values into the loading equation found in §85.3.a.2.ii.

(D) Compare the applied load with the target load from the EPA-approved lookup table (or the applicable table for the particular emissions inspection program)

(c) Emission Sampling System.

(1) Leak Check. The entire sample system shall be checked for vacuum leaks on a daily basis and proper flow on a continuous basis. This may be accomplished using a vacuum decay method, reading a span gas, or other methods proposed by a state and approved by the Administrator. The analyzer shall not allow an error of more than 1% of reading using the high-range span gas described in §85.4(d)(2)(iii)(C). The analyzer shall be locked out from testing if the leak check is not performed when due or fails to pass the check.

(2) Dilution. The flow rate on the analyzer shall not cause more than 10% dilution during sampling of exhaust of a 1.6 liter engine a normal idle. Ten percent dilution is defined as a sample of 90% exhaust and 10% ambient air.

(3) Dilution Acceptance Test.

(i) Set vehicle with 1.6 liter maximum engine displacement at factory - recommended idle speed, OEM configuration exhaust system, transmission in neutral, hood up (a fan to cool the engine may be used if needed). Set idle speed not to exceed 920 RPM. (Set for 900 RPM with a tolerance ± 20 RPM.)

(ii) With a laboratory grade analyzer system, sample the exhaust at 40 centimeters depth with a flow sample rate below 320 liters per hour. Allow sufficient time for this test. Record all HC, CO, NO, CO_2, and O_2 readings. A chart recorder or electronically stored data may be used to detect the point of stable readings.

(iii) While operating the candidate analyzer system in a mode which has the same flow rate as the official test mode, record the levels of HC, CO, NO, CO_2, and O_2. Ensure that the probe is installed correctly.

(iv) Repeat step (ii).

(iv) Acceptance Criteria: If the difference of the readings between (ii) and (iv) exceed five percent of the average of (ii) and (iv), repeat (ii), (iii), and (iv); otherwise average (ii) and (iv) and compare with (iii). If (iii) is within 10 percent of the average of (ii) and (iv), then the equipment meets the dilution specification.

(d) Analytic Instruments.

(1) General Requirements. The analyzer shall, to the extent possible, maintain accuracy between gas calibrations taking into account all errors, including noise, repeatability, drift, linearity, temperature, and barometric pressure.

(2) Two-Point Gas Calibration and Low-Range Audit.

(i) Analyzers shall automatically require a zero gas calibration and a high-range gas calibration for HC, CO, NO, and CO_2. The system shall also use a low-range gas to check the calibration in the range of vehicle emission standards. In high volume stations (4000 or more tests per year), analyzers shall be calibrated within four hours before each test. In low volume stations (below 4000 tests per year), analyzers shall be calibrated within 72 hours before each test. If the system does not calibrate or is not calibrated, the analyzer shall lock out from testing until corrective action is taken. This calibration check shall include measuring the NO cell response to ensure it is < 15 seconds with a warning displayed when the response exceeds 7 seconds.

(ii) Gas Calibration and Check Procedure. Gas calibration shall be accomplished by introducing calibration gases that meet the requirements of §85.4(d)(2)(iii) into the calibration port. The pressure in the sample cell shall be the same with the calibration gas flowing as with the sample flowing during testing. The analyzer channels shall be adjusted to the center of the allowable tolerance range as a result of the calibration. The system shall record the gas reading data from before the adjustment and other data pertinent to control charting analyzer performance.

(A) Zero the analyzer and perform a leak check.

(B) Calibrate the analyzer using the low and high-range calibration gas as specified in §85.4(d)(2)(iii).

(C) Purge the analyzers completely by flowing the low-range calibration gas specified in §85.4(d)(2)(iii) for 60 seconds. If the low-range calibration gas readings differ from the true cylinder value by more ±3% of point for HC, ±3% of point for CO, ±3% of point for CO_2, or ±25 ppm NO the analyzer shall be locked out from testing.

(iii) The following gases shall be used for the 2-point calibration and low-range audit. The Low- and High-Range Calibration Gases are the same concentrations and purity as the Low- and High-Range Audit Gases.

Appendix A contains a table with sample calculations illustrating how the Low and High Audit Limits for the Calibration Gases are to be determined. The tolerances are based on a 2% blend tolerance, accurate to 1%. It is recommended that NIST traceable standards accurate to 1% be used to verify all bottle names[*].

(A) Zero Gas

O2	=	20.7%
HC	<	1 ppm THC
CO	<	1 ppm
CO_2	<	400 ppm
NO	<	1 ppm
N_2	=	Balance 99.99 % pure

(B) Low-Range Calibration Gas

HC	=	200 ppm propane
CO	=	0.5 %
CO_2	=	6.0 %
NO	=	300 ppm
N_2	=	Balance 99.99 % pure

(C) High-Range Calibration Gas

HC	=	3200 ppm propane
CO	=	8.0 %
CO_2	=	12.0 %
NO	=	3000 ppm
N_2	=	Balance 99.99 % pure

(iv) Traceability. The audit and span gases used for the gas calibration shall be traceable to National Institute of Standards and Technology (NIST) standards ±1%. Gases shall have a 2% blend tolerance.

(3) Five-Point Calibration Audit.

(i) Analyzers shall automatically require and successfully pass a five point gas audit for HC, CO, NO, and CO_2. For high volume stations, audits shall be checked monthly. In low volume stations, analyzers shall undergo the audit procedure every six months.

(ii) Gas Audit Procedure. Calibration auditing shall be accomplished by introducing audit gas through the probe. The pressure in the sample cell shall be the same with the audit gas flowing as with the sample flowing during testing.

(A) Zero the analyzer and perform a leak check.

[*] EPA has been informed that adherence to this minimum NIST standard may not be an ironclad guarantee of accuracy. Requiring gases to be analyzed using EPA-600/R-97-121 may be a more reliable method; however, it may also cause a significant increase in cost.

(B) Flow the low range audit gas specified in §85.4(d)(3)(iii) through the sample probe, ensuring that the tip is equal to ambient barometric pressure ±0.1 inches Hg (a balloon teed into the gas flow line is an acceptable pressure indicator; the balloon should stand slightly erect).

(C) When the HC, CO, NO, and CO_2 gases have been flowing for 60 seconds record the readings as well as the PEF value for HC at each audit blend.

(D) Repeat steps B and C for each audit gas specified in §85.4(d)(3)(iii).

(E) Compare the readings with the audit gas values using the equation listed below. Be sure to divide the HC reading by its PEF if this calculation is not performed automatically in the analyzer software.

$$\text{Tolerance \%} = 100 * \frac{(\text{Reading} - \text{True Cylinder Value})}{\text{True Cylinder Value}}$$

(F) If the analyzer response when reading any of the Audit Gases exceeds ±4.0% for HC/PEF, CO, and CO_2, or ±5.0% for NO, then the analyzer shall fail the gas audit and shall be locked out from testing until it passes.

(iv) The following gases shall be used for the five-point calibration audit.

(A) Zero Audit Gas

O2	=	20.7% (if O2 span is desired)
HC	<	0.1 ppm THC
CO	<	0.5 ppm
CO_2	<	1 ppm
NO	<	0.1 ppm
N_2	=	Balance 99.99 % pure

(B) Low Range Audit Gas

HC	=	200 ppm propane
CO	=	0.5 %
CO_2	=	6.0 %
NO	=	300 ppm
N_2	=	Balance 99.99 % pure

(C) Low-Middle Range Audit Gas

HC	=	960 ppm propane
CO	=	2.4 %
CO_2	=	3.6 %
NO	=	900 ppm
N_2	=	Balance 99.99 % pure

(D) High-Middle Range Audit Gas

HC	=	1920 ppm propane
CO	=	4.8 %
CO_2	=	7.2 %
NO	=	1800 ppm

N_2 = Balance 99.99 % pure

(E) High Range Audit Gas
HC = 3200 ppm propane
CO = 8.0 %
CO_2 = 12.0 %
NO = 3000 ppm
N_2 = Balance 99.99 % pure

(iv) Traceability. These gases shall be traceable to National Institute of Standards and Technology (NIST) standards ±1%. Gases shall have a 2% blend tolerance.

(4) Service, Repair and Modification.

(i) Each time an analyzer's emissions measurement system, sensor, or other related electronic components are repaired or replaced, the five point calibration audit required in §85.4(d)(3) shall be performed, at a minimum, prior to returning the unit to service.

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

(5) Certification Testing.

(i) Analyzer accuracy. This test confirms the ability of the candidate instruments to read various concentrations of gases within the tolerances required by this specification. The test compares the response of the candidate instrument with that of standard instruments, and also estimates the uncertainty of the readings.

The analyzer shall be zeroed and gas calibrated using the high-range calibration gas. The instrument shall be tested using propane, carbon monoxide, carbon dioxide, and nitric oxide in nitrogen, with a certified accuracy of ±1%, in the following concentrations: 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100% of the high range audit gas

(A) Introduce the gases in ascending order of concentrations beginning with the zero gas. Record the readings of the standard and candidate instruments to each concentration value. A gas divider may be used to divide the high range audit gas to the concentrations described in §85.4(d)(5)(i).

(B) After the highest concentration has been introduced and recorded, introduce the same gases to the standard and candidate analyzers in descending order, including the zero gas. Record the reading of analyzers to each gas, including negatives (if any).

(C) Repeat steps A and B for the candidate only, four more times (total of five times).

(D) Calculation Procedure:

1. Calculate the average value of each concentration for the readings of the standard instruments.

2. Calculate the mean and standard deviation of each candidate's readings for each concentration. Include both upscale and downscale readings for the same gas concentration. (All calculations may not be possible for zero concentrations.)

3. For each concentration, calculate the difference between the candidate mean and the standard average.

4. For each concentration, compute the following:

   (i) $Y_1 = x + K_{sd}$

   (ii) $Y_2 = x - K_{sd}$

   Where

   K_{sd} = std dev * 3.5 for zero and the highest concentration value

   K_{sd} = std dev * 2.5 for all other concentration values

   x = mean (arithmetic average) of the set of candidate readings.

5. Compute the uncertainty (U) of the calibration curve for each concentration as follows:

   (i) U_1 = concentration value - Y_1

   (ii) U_2 = concentration value - Y_2

6. *Acceptance Criteria:*

   (a) For each concentration, the differences calculated in Step 3 shall be no greater than the accuracy tolerances specified in §85.3(c)(3) for each instrument.

   ~~(b)~~ For each concentration, the uncertainties, (U_1 and U_2) shall be no greater than the accuracy tolerances required in §85.3(c)(3).

(E) Alternative Calculation Procedure:

1. Use a gas divider readings as the standard values and compare them to the measured values of a sample lot of instruments

2. Compute the absolute and percent of point deltas using the equation in Section §85.4(d)(3)(ii)(E).

3. For each point, the instruments shall pass the criteria provided in Section §85.4(d)(3)(ii)(F).

(ii) Analyzer System Repeatability. This test characterizes the ability of the instrument to give consistent readings when repeatedly sampling the same gas concentration.

(A) Using the high range span gas, introduce the gas through the calibration port. Record the readings.

(B) Purge with ambient air for at least 30 seconds but no more than 60 seconds.

(C) Repeat steps A and B above four more times.

(D) Repeat steps A, B, and C, introducing the gas through the sample probe.

(E) *Acceptance Criteria:* The differences between the highest and lowest readings from both ports shall not exceed the values specified in §85.3(c)(3)(vi).

(iii) Analyzer System Response Time. This test determines the speed of response of the candidate instrument when a sample is introduced at the sample probe.

(A) Gas calibrate the candidate instrument per the manufacturer's instructions.

(B) Using a solenoid valve or equivalent selector system, remotely introduce an high range span gas to the probe. The gas pressure at the entrance to the probe shall be equal to room ambient.

(C) Measure the elapsed time required for the instrument display to read 90% and 95% of the final stabilized reading for HC, CO, CO_2 and NO. (Optional: Also, measure the time required for the O_2 analyzer to read 0.1% O_2). Alternatively the bench outputs may be recorded against a time base to determine the response time. Record all times in seconds.

(D) Switch the solenoid valve to purge with zero air for at least 40 seconds but no more than 60 seconds.

(E) Measure the elapsed time required for the NO instrument display to read 10% of the stabilized reading in Step C.

(F) Repeat steps A, B, and C, two more times (total three times).

(G) *Acceptance Criteria:* The response (drop time for O_2 and NO; rise time for HC, CO, CO_2 and NO) times shall meet the requirement specified in §85.3(c)(2)(x). The response time shall also be within ±1 second of the nominal response time supplied by the equipment supplier for use in §85.5(b)(5).

(iv) Analyzer Interference Effects. The following acceptance test procedure shall be performed at 45°F, 75°F, and 105°F conditions, except as noted.

(A) Zero and span the instrument.

(B) Sample the following gases for at least one minute. Record the response of each channel to the presence of these gases.

1. 16% Carbon Dioxide in Nitrogen.
2. 1600 ppm Hexane in Nitrogen.
3. 10% Carbon Monoxide in Nitrogen.
4. 3000 ppm Nitric Oxide in Nitrogen.
5. 75 ppm Sulfur Dioxide (SO_2) in Nitrogen.
6. 75 ppm Hydrogen Sulfide (H_2S) in Nitrogen.

(C) Water-Saturated Hot Air. Water-saturated hot air shall be drawn through the probe from the top of a sealed vessel partially filled with water through which ambient air will be bubbled. The water shall be maintained at a temperature of 122°F ± 9°F. This test shall be performed at only the 75°F, and 105°F conditions.

(D) *Acceptance Criteria:* The interference effects shall not exceed the limits specified in §85.3(c)(2)(iii).

(v) Electromagnetic Isolation and Interference. This test shall measure the ability of the candidate instrument to withstand electromagnetic fields which could exist in vehicle testing and repair facilities. For all tests described below, sample "Low-Middle Range Audit Gas" specified in §85.4(d)(3)(iii)(C), at atmospheric pressure, through the sample probe. Record analyzer reading during test periods.

(A) Radio Frequency Interference Test.

1. Use a test vehicle with an engine having a high energy ignition system (or equivalent), a solid core coil wire and a 3/8" air gap. Leave engine off.

2. Locate the candidate instrument within 5 feet of the ignition coil. Gas calibrate the candidate instrument.

3. Sample gas specified above. Wait 20 seconds, and record analyzer readings.

4. Start engine. With the hood open and gas flowing to the analyzer, cycle the engine from idle through 25 mph on the dynamometer at ASM loads and record the analyzer readings.

5. Relocate the instrument to within 6 inches of one side of the vehicle near the engine compartment. Follow procedure described in step 4 and record analyzer readings.

6. Relocate the instrument to within 6 inches of the other side of the vehicle near the engine compartment. Follow procedure described in step 4 and record analyzer readings.

7. *Acceptance Criteria:* The analyzer readings shall deviate no more than 0.5% full scale.

(B) Induction Field Test. Use a variable speed (commutator type) hand drill having a plastic housing and rated at 3 amps or more. While the analyzer is sampling the gas, vary the drill speed from zero to maximum while moving from the front to the sides of the instrument at various heights.

Acceptance Criteria: The analyzer readings shall deviate no more than 0.5% full scale.

(C) Line Interference Test. Plug the drill used in part B above into one outlet of a #16-3 wire extension cord approximately 20 feet long. Connect the instrument into the other outlet of the extension cord. Repeat part B above.

Acceptance Criteria: The analyzer readings shall deviate no more than 0.5% full scale.

(D) VHF Band Frequency Interference Test. Locate both a citizens ban radio (CB), with output equivalent to FCC legal maximum, and a highway patrol transmitter (or equivalent) within 50 feet of the instrument. While the analyzer is sampling the gas, press and release transmit button of the both radios several times.

Acceptance Criteria: The analyzer readings shall deviate no more than 0.5% full scale.

(E) Ambient Conditions Instruments. Upon installation and every six months thereafter, the performance of the ambient conditions instruments shall be cross-checked against a master weather station.

Acceptance Criteria: The individual instruments shall be within the tolerance specified in §85.3(c)(4).

(v) Ambient Conditions Instruments. Upon installation and every six months thereafter, the performance of the ambient conditions instruments shall be cross checked against a master weather station.

Acceptance Criteria: The individual instruments shall be within the tolerance specified in §85.3(c)(4).

§85.5 Test Record Information

The following information shall be collected for each test performed (both passing and failing tests), recorded in electronic form, and made available to EPA upon request.

(a) General Information.

(1) Test Record Number
(2) Inspection station and inspector numbers
(3) Test system number
(4) Dynamometer site
(5) Date of test
(6) Emission test start time and the time final emission scores are determined.
(7) Vehicle identification number
(8) License plate number
(9) Test certificate number
(10) Vehicle model year, make, and type
(11) Number of cylinders or engine displacement
(12) Transmission type
(13) Odometer reading
(14) Type of test performed (i.e., initial test, first retest, or subsequent retest)

(b) Ambient Test Conditions.

(1) Relative humidity (%)
(2) Dry-bulb temperature (°F).
(3) Atmospheric pressure (mm Hg)
(4) NO correction factor
(5) Nominal response time for each instrument (Transport + T90)

(c) ASM Mode or Modes.

The following information shall be captured separately for each test mode (ASM5015 and/or ASM2525) performed.

(1) Final HC running average (AvgHC) (ppm)
(2) Final CO running average (AvgCO) (%)
(3) Final NO running average (AvgNO) (ppm)
(4) Total horsepower used to set the dynamometer (THP5015) (hp)
(5) Engine RPM running average corresponding to the final test score
(6) Dilution correction factor (DCF)

(d) Diagnostic/Quality Assurance Information.

(1) Test time (seconds)
(2) Mode time (seconds)
(3) Vehicle speed (mph) for each second of the test
(4) Engine RPM for each second of the test
(5) Dynamometer load (pounds) for each second of the test
(6) HC concentration (ppm) for each second of the test, not corrected for dilution
(7) CO concentration (%) for each second of the test, not corrected for dilution

(8) NO concentration (ppm) corrected for humidity for each second of the test, not corrected for dilution
(9) CO_2 concentration (%) for each second of the test
(10) O_2 concentration (%) for each second of the test (optional)

Appendix A: Calculating Audit Tolerances

"Actual Cylinder" field is input by the auditor in ppm or %. Audit limits are calculated and filled in by the spreadsheet (or the auditor). The tolerances are based on a 2% blend tolerance, accurate to 1%. It is recommended that NIST traceable standards accurate to 1% be used to verify all bottle names.

Spreadsheet for Calculating ASM Audit Tolerances

Range	Gas	Gas Concentration		Accuracy			Audit Tolerance			Applied Tolerance (greater of % or point)	Audit Limits	
		Recom-mended	Actual Cylinder	% of Reading	Point	Gas	% of Reading	% (as point)	Point		Low	High
High	HC (ppm)	3200	3191	3.0%	8	1.0%	4.0%	128	40	128	3063	3319
	CO (%)	8.00	8.11	3.0%	0.02	1.0%	4.0%	0.32	0.10	0.32	7.79	8.43
	CO2 (%)	12.00	11.90	3.0%	0.30	1.0%	4.0%	0.48	0.42	0.48	11.42	12.38
	NO (ppm)	3000	2987	4.0%	25	1.0%	5.0%	149	55	149	2838	3136
Mid High	HC (ppm)	1920	1918	3.0%	8	1.0%	4.0%	77	27	77	1841	1995
	CO (%)	4.80	4.83	3.0%	0.02	1.0%	4.0%	0.19	0.07	0.19	4.64	5.02
	CO2 (%)	7.20	7.15	3.0%	0.30	1.0%	4.0%	0.29	0.37	0.37	6.78	7.52
	NO (ppm)	1800	1801	4.0%	25	1.0%	5.0%	90	43	90	1711	1891
Mid Low	HC (ppm)	960	960	3.0%	8	1.0%	4.0%	38	18	38	922	998
	CO (%)	2.40	2.39	3.0%	0.02	1.0%	4.0%	0.10	0.04	0.10	2.29	2.49
	CO2 (%)	3.60	3.57	3.0%	0.30	1.0%	4.0%	0.14	0.34	0.34	3.23	3.91
	NO (ppm)	900	902	4.0%	25	1.0%	5.0%	45	34	45	857	947
Low	HC (ppm)	200	203	3.0%	8	1.0%	4.0%	8	10	10	193	213
	CO (%)	0.50	0.49	3.0%	0.02	1.0%	4.0%	0.02	0.02	0.02	0.47	0.51
	CO2 (%)	6.00	6.01	3.0%	0.30	1.0%	4.0%	0.24	0.36	0.36	5.65	6.37
	NO (ppm)	300	299	4.0%	25	1.0%	5.0%	15	28	28	271	327
Zero	HC (ppm)	0	0	3.0%	8	1.0%	4.0%	0	9	9	-9	9
	CO (%)	0.00	0.00	3.0%	0.02	1.0%	4.0%	0.00	0.02	0.02	-0.02	0.02
	CO2 (%)	0.00	0.00	3.0%	0.30	1.0%	4.0%	0.00	0.30	0.30	-0.30	0.30
	NO (ppm)	0	0	4.0%	25	1.0%	5.0%	0	26	26	-26	26

In the "Actual Cylinder" column, enter the gas concentrations from the audit cylinders
The audit low and high tolerances are calculated in the columns on the right