Appendix A: Test Procedures

Test Procedure to Evaluate the Acceleration Simulation Mode and the Emissions Measurement Capabilities of a BAR90 Certified Analyzer With An Integrated Fuel Cell Type NO Analyzer

1.0 Objectives

The objective of this ASM test project was to collect data to compare the effectiveness of a four-mode steady-state test procedure as an alternative I/M test to the IM240. Emissions and canister purge flow data were collected using the following vehicle operating modes:

- Two Acceleration Simulation Modes (5015 and 2525)

- A 50 mph steady state mode at road load

- An idle mode in Drive

- An idle mode in Neutral

These modes will subsequently be referred to as the ASM test. The same data were collected for the IM240 test.

The lower cost of the emissions measurement equipment is the salient feature that makes the ASM attractive to its proponents. Therefore, EPA made ASM emissions measurements using a certified BAR90 analyzer (for HC, CO, and CO_2) with an integrated NO analyzer of the fuel cell type for NO measurements. For the IM240 a CVS-based emissions measurement system was used.

Canister purge flow measurements were made with the same 0-50 liter per minute for both the ASM and IM240.

The testing was carried out in two locations, a single I/M lane in an official Arizona I/M station and at a laboratory owned by Automotive Testing Laboratories (ATL). Both were located in Mesa, Arizona.

2.0 Phoenix Lane Procedure

The following is a description of the I/M lane procedures.

- This procedure was restricted to 1983 and newer light duty vehicles with fuel injection, when available. Carbureted 1983 & newer vehicles were tested when fuel injected vehicles were unavailable. Pre-1983 light duty vehicles were tested only when 1983 and newer vehicles were unavailable.

- Each light duty vehicle received:

  1. The ASM test that included the following modes in the sequence listed:

     - ASM5015 with purge,
     - ASM2525 with purge,
     - 50 mph at road load, with purge,
     - idle test (automatic transmissions in drive),
     - idle test (automatic transmissions in neutral) for the first 50 cars. Car 51 and subsequent cars will not get the 5th mode.

These four or five modes will be referred to as the ASM series.

2. An IM240 with purge.

3. A pressure test.

4. An Arizona State I/M test.

2.1 Procedure Sequence

- In general all odd numbered vehicles got the IM240 as the initial test and all even numbered vehicles got the ASM as the initial test.

- Data collected included a number 1 or 2 in a field named "Test.Order" to designate whether the ASM series procedure was run first or second. Discrepancies between the Test.Order entry and even/odd vehicle numbers are resolved by relying on the Test.Order entry, as this was ATL's primary means to identify test order.

2.2 Measurement Equipment

- For the ASM series, a certified BAR90 HC/CO/CO_2 exhaust emission analyzer was used to measure HC, CO, and CO_2, with an integrated NO analyzer using a fuel cell sensor. ATL only acquired a NO analyzer/BAR90 analyzer combination that provided second-by-second data for HC, CO, CO_2, and NO. The data output for the ASM test went to 3-

1/2 inch floppy discs that included run number, time (sec), mode number, vehicle speed, purge flow, NO (ppm), HC (ppm), CO2 (%), CO (%), actual torque, required torque, actual horsepower and required horsepower.

- A 50 liter/min Sierra flow meter was used to measure total canister purge flow. The flow meter system output was the cumulative second-by-second data for total flow recorded on the 3-1/2" floppy discs discussed above.

- For the IM240, normal measurements with the CVS system continued at the lane. The data collected included time (sec), bag number, ambient measurements, NOx (grams/second), HC (g/sec), CO_2 (g/sec), CO (g/sec), and purge in standard liters.

2.3 Procedure Details

- An electric Clayton dynamometer was used for both the IM240 and the ASM series. The dynamometer horsepower settings for the ASMs were as follows:
  - 5015 HP = (ETW / 250)
  - 2525 HP = (ETW / 300)
  - 50 Mph HP = Road Load

  The horsepower and inertia weight settings for the IM240 were as normally performed. The minimum inertia weight setting (2,000 lbs.) was used for the ASMs.

- Manual transmission vehicles were tested in second gear for both the ASM5015 and the ASM2525. The 50 mph road load mode used the top non-overdrive gear, typically 4th gear on a 5-speed, 4th gear on a 4-speed, and 3rd gear on a 3-speed. Drivers used a lower gears for vehicles that were lugging.

- The engine was shut off prior to the IM240 and the ASM5015 (as will normally be done by I/M programs to connect the purge meter), regardless of which procedure was performed first, and restarted just prior to initiating these procedures. The engine was not shut off between ASM modes, and the vehicle was accelerated from the current mode up to the next mode speed, without first returning to zero.

- The ASM emission sampling period and the canister purge flow measurement period were as follows:

1. Each ASM mode was ini tiated after the vehicle speed had achieved the nominal speed (15, 25, or 50 mph, and 0 mph idle) ±2 mph. Once up to speed, emissions sampling of one second average concentrations continued for 40 seconds. Emission scores for HC, CO, CO2 and NO were reported for each second. Emissions scores for the first 10 seconds of each mode were ignored to allow the dynamometer to stabilize and to allow for transport time to the analyzers.

2. The purge flow reported was the second by second cumulative flow over the entire ASM cycle, including transient accelerations. The nominal acceleration rate was 3.3 mph/sec., with a minimum acceleration rate of 1.8 mph/sec and a maximum of 4.3 mph/sec. The table below lists the minimum, nominal, and maximum acceleration times used to accelerate from one mode to another. For example, the table shows that the time to accelerate from 25 mph to 50 mph should be 7.6 seconds., but can take as long as 13.9 seconds., and as little as 5.8 seconds. The zero to 60 mph time is provided to indicate how the specified acceleration times relate to a commonly known reference of vehicle performance. ATL used a video driver’s aid with the nominal acceleration rate.

	Acceleration Rate (mph/sec)	Time to Accelerate from-to: 0-15 mph (secs)	15-25 mph (secs)	25-50 mph (secs)	0-60 mph (secs)
Minimum	4.3	3.5	2.3	5.8	14.0
Nominal	3.3	4.5	3.0	7.6	18.2
Maximum	1.8	8.3	5.6	13.9	33.3

- During the accelerations between modes, the dynamometer load setting did not exceed road load. This was specified to enhance the opportunity for canister purge during the ASM accelerations. The combination of the ASM load and the base 2,000 lb. inertia may load some vehicles to heavily to allow purge to initiate.

3.0 Lab Recruitment

Light duty vehicles that received all of the lane tests (IM240, ASM series, and Arizona I/M test), were recruited for testing at ATL’s laboratory. Cars were categorized as passing or failing using the IM240 cutpoints in the table below:

Phoenix Lane IM240 Cutpoints for Lab Procurement

Model Years	HC g/mile	CO g/mile	NOx g/mile
1983+	>0.80	>15.0	>2.0

The following table provides the laboratory recruitment goals for the pass/fail categories listed as a percentage of the total number of cars recruited to the lab for this task. The initial recruitment target was 100 vehicles.

Phoenix Lab Recruitment Goals Using Lane IM240 Categories

Model Years	HC/CO Pass	HC/CO Fail	NOx Pass	NOx Fail
1986+	15%	15%	15%	15%
1983-85	10%	10%	10%	10%

4.0 Commercial Repair Recruitment

Owners of vehicles that failed the Arizona I/M test, and received and IM240/ASM series, were offered $50 to return to the lane for after-repair tests. These vehicle owners were only offered this incentive if they refused to participate in the laboratory testing program or if their vehicles were not needed for laboratory recruitment. Recruiting vehicles for laboratory tests was a higher priority than for commercial repair participation.

The owners were informed that they must return with repair receipts indicating repairs by a commercial establishment with itemized labor and parts costs to qualify for the $50 incentive. ATL included either the original receipts or copies in the vehicle test packets that ATL provided to EPA. In addition, ATL provided summarized comments and data for these vehicles on electronic disk.

Vehicles returning after commercial repairs followed the same procedures.

5.0 Lab Procedure

The lab procedure is summarized in Attachment 1, so this section will only add explanations to the procedure listed in Attachment 1.

5.1 Two Groups

The vehicles recruited to the lab were separated into two groups:

1. Those whose initial lane test was the IM240 and were repaired to IM240 targets. For the vehicles in this group, the IM240 always precedes the ASM series (see Attachment 1).

2. Those whose initial lane test was the ASM series and were repaired to ASM targets. There were not enough data to set ASM repair targets, so IM240 targets were used for both groups. For the vehicles in this group, however, the ASM series always preceded the IM240 (see Attachment 1).

5.2 Repair Targets

The repair targets were to achieve 0.80/15.0/2.0 on the IM240 for both the ASM-targeted group and the IM240-targeted group. Initially, repair targets were to be provided to ATL for the ASM targeted group to replace the IM240 targets. However, due to time and data constraints this proved impossible.

For the initial repair attempt, the mechanic was only aware of the lane IM240 score for both vehicle groups (initial lane test: ASM or IM240). For subsequent repair attempts, the mechanics were only be aware of lane and lab IM240 scores. FTP scores were not provided to the mechanics for either group.

Repairs were limited to $1,000.

5.3 Laboratory Test Equipment

Due to time and financial constraints, EPA was unable to develop lab ASM capability. The IM240 and FTP were measured with a CVS system. Modal or second-by-second CVS capability was not available at the laboratory.

ASM/IM240 Lab Procedure

Revision Date: 10/21/92
Number tested =
Recruitment: 1983+ fuel injected only.
Repairs: Get IM240 Indolene to .8/15/2.0. The mechanic should only be aware of IM240 scores for the IM240 targetted repairs. $1,000 repair limit/car - catalyst if necessary, aftmrkt preferred.

Develop explanations for any IM240 failures that pass FTP, while veh is still at lab.

Tank Fuel

On-Road Warmup
Tank Fuel IM240

9.0 RVP Indolene As-Received

LA-4 Prep cycle @ 80°F
No Diurnal
FTP Exhaust
No Hot Soak
IM240 Indolene (with purge if available)

Repair to get IM240 Indolene to .8/15/2.0. The mechanic should only be aware of IM240 scores - not FTP scores, and only perform minimum repairs necessary to achieve targets.

Report After-First-Repair Indolene IM240 regardless of outcome. Mechanic will only be aware of lane IM240 score for first repair, not lab tank fuel score.
Continue repairs if necessary. Don't perform FTP until .8/15/2.0 is achieved.

9.0 RVP Indolene After-Repair to IM240 0.8/15/2.0

3 LA-4 Prep cycles @ 80°F for all vehicles
Top off to 40% fill - don't drain.
FTP Exhaust
IM240 Indolene RM1 (w/purge if

Stop repairs even if failing FTP.

Indolene Lane Tests For Vehicles Whose Initial Lane Test Was IM240

On-Road Warmup
Lane Indolene IM240
ASM Series

Indolene Lane Tests Procedure for Vehicles Whose Initial Lane Test Was ASM Series

On-Road Warmup
ASM Series
Lane Indolene IM240

Appendix B

Data Listings

Vehicle Information					FTP Scores			IM240 SCORES					ASM		
								Composites			Bag 2 score		Composite Scores		
Veh#	Run#	Test	Date	Order	HC	CO	NOx	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
3148	1672	TST17	921030	IM240.2nd	0.11	1.1	0.97	0.03	1.3	0.55	0.04	1.1	0.13	3.8	0.51
3149	1685	TST17	921102	IM240.1st	0.2	2.3	0.2	0.21	2.8	1.19	0.16	2.2	0.19	3.3	0.77
3150	1692	TST17	921030	IM240.2nd	2.43	82.9	0.59	1.44	32.6	0.95	0.79	14.7	1.40	72.5	0.56
3151	1696	TST17	921102	IM240.2nd	0.34	3.5	5.81	0.2	2.0	4.54	0.1	2.7	0.47	3.3	2.09
3152	1709	TST17	921103	IM240.1st	0.18	3.6	1.01	0.12	2.8	1.34	0.09	2.6	0.10	4.0	0.35
3154	1739	TST17	921103	IM240.1st	0.31	6.2	1.04	0.34	4.4	2.24	0.23	3.4	0.31	8.2	1.70
3155	1735	TST17	921103	IM240.1st	3.25	46.7	0.26	2.77	24.1	1.2	2.06	17.2	0.43	5.8	0.50
3156	1726	TST17	921104	IM240.2nd	0.31	6.7	1.07	0.45	6.1	2.07	0.45	6.2	0.19	3.8	1.04
3157	1747	TST17	921104	IM240.1st	1.7	14.3	2.14	2.84	34.7	2.95	2.26	15.7	1.59	11.3	2.56
3158	1753	TST17	921104	IM240.1st	0.15	2.6	0.85	0.16	2.4	2.44	0.07	1.6	0.11	2.9	0.90
3159	1752	TST17	921105	IM240.2nd	1.11	74.2	0.31	0.75	41.2	0.49	0.83	49.2	0.57	38.8	1.01
3160	1749	TST17	921105	IM240.1st	0.29	3.0	1.26	0.21	2.8	2.27	0.18	2.6	0.15	3.4	1.31
3161	1754	TST17	921105	IM240.2nd	0.28	5.1	1.7	0.24	4.1	2.42	0.23	4.6	0.16	5.8	2.04
3162	1777	TST17	921106	IM240.1st	0.35	3.7	1.25	0.77	6.7	3.08	0.35	2.9	0.11	3.1	1.05
3165	1810	TST17	921106	IM240.2nd	1.96	13.2	2.5	1.59	7.3	2.48	1.5	6.9	0.40	4.7	1.14
3169	1677	TST17	921109	IM240.1st	1.04	15.0	0.96	0.85	14.2	0.98	0.79	14.7	1.68	17.3	0.74
3170	1879	TST17	921109	IM240.1st	0.42	7.2	1.16	0.34	7.6	2.02	0.24	6.6	0.16	3.9	1.32
3171	1891	TST17	921118	IM240.1st	0.15	3.2	0.52	0.1	2.3	0.46	0.07	2.8	0.12	2.9	1.07
3172	1895	TST17	921120	IM240.1st	0.16	3.3	0.73	0.12	2.1	3.3	0.09	1.8	0.21	3.6	0.61
3173	1804	TST17	921111	IM240.2nd	0.37	6.7	0.82	0.18	3.7	0.84	0.13	2.9	0.11	2.9	0.91
3174	1688	TST17	921111	IM240.2nd	0.74	16.3	1.88	0.76	19.3	2.5	0.62	16.6	0.31	9.8	2.03
3175	1907	TST17	921120	IM240.1st	0.4	13.1	0.46	0.9	47.8	0.63	1.04	59.7	0.20	12.9	0.84
3178	1965	TST17	921118	IM240.1st	0.2	1.6	0.82	0.09	1.8	0.72	0.08	1.6	0.20	3.3	0.64
3179	1966	TST17	921220	IM240.2nd	2.9	77.6	2.06	1.84	55.9	1.6	1.71	54.3	2.44	89.0	2.10
3180	2005	TST17	921123	IM240.1st	0.96	9.8	1.22	1.33	8.5	2.34	1.09	5.9	0.16	3.6	0.68
3181	2015	TST17	921120	IM240.1st	0.2	3.4	0.48	0.13	1.2	0.69	0.1	1.3	0.22	3.3	0.77
3182	2019	TST17	921120	IM240.1st	1.47	26.2	1.12	1.53	18.0	1.36	1.44	17.5	1.07	22.1	2.16
3183	2024	TST17	921124	IM240.2nd	3.13	66.3	0.7	1.29	26.0	0.85	1.01	20.6	1.92	34.8	1.59
3184	2128	TST17	921125	IM240.2nd	0.3	3.0	0.48	0.14	3.5	0.52	0.15	2.9	0.34	4.4	1.09
3185	2130	TST17	921125	IM240.2nd	0.43	7.4	1.27	0.33	7.7	1.32	0.31	7.7	0.74	11.8	2.86
3186	2152	TST17	921125	IM240.2nd	0.19	2.3	0.17	0.15	1.4	0.17	0.19	1.7	0.18	3.9	0.31
3187	2131	TST17	921127	IM240.1st	0.26	2.3	0.66	0.23	2.7	1.42	0.18	2.5	0.12	3.5	0.87
3188	2160	TST17	921127	IM240.2nd	4.49	17.8	0.2	4.02	14.4	0.1	3.21	14.2	3.78	15.1	0.31

Vehicle Information					FTP Scores			IM240 SCORES					ASM		
								Composites			Bag 2 score		Composite Scores		
Veh#	Run#	Test	Date	Order	HC	CO	NOx	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
3189	2165	TST17	921127	IM240.1st	0.4	5.9	1.24	0.17	3.2	1.41	0.15	3.1	0.12	4.1	1.33
3190	2161	TST17	921201	IM240.1st	13.07	42.0	0.56	7.06	24.8	0.79	5.77	23.1	4.27	12.7	0.80
3191	2164	TST17	921130	IM240.2nd	0.32	3.3	0.56	0.17	3.5	0.45	0.18	3.6	0.22	4.4	0.62
3192	1995	TST17	921130	IM240.1st	0.49	6.3	0.53	0.5	8.7	0.76	0.41	9.0	0.42	6.6	0.92
3193	2176	TST17	921130	IM240.2nd	0.61	5.0	0.97	0.86	6.6	1.33	0.72	5.6	0.41	3.4	2.79
3194	2202	TST17	921201	IM240.2nd	2.29	47.1	1.92	1.42	20.2	1.69	1.39	20.4	1.04	43.2	2.16
3195	2200	TST17	921202	IM240.2nd	0.51	5.8	0.66	0.21	3.5	0.9	0.2	3.7	0.19	3.3	1.27
3196	2230	TST17	921201	IM240.2nd	2.87	26.5	5.81	2.73	13.9	5.1	2.54	13.7	1.49	15.9	5.88
3197	2238	TST17	921201	IM240.2nd	1.29	3.5	2.42	0.99	8.3	2.66	0.88	8.7	0.86	7.7	2.97
3198	2198	TST17	921201	IM240.2nd	1.77	10.2	1.8	1.51	8.5	2.04	1.31	8.2	1.07	7.4	2.50
3199	2244	TST17	921203	IM240.2nd	0.53	10.9	1.53	0.3	9.6	1.15	0.25	9.1	0.37	4.1	1.74
3200	2245	TST17	921203	IM240.1st	0.59	0.3	0.69	0.29	1.6	2.49	0.27	1.5	0.13	2.9	1.58
3201	2237	TST17	921202	IM240.1st	0.94	19.7	1.72	1.15	8.8	1.82	0.52	6.0	0.19	4.5	1.08
3202	2273	TST17	921203	IM240.1st	0.5	7.5	7.56	0.23	3.6	7.88	0.2	3.2	0.17	3.1	6.51
3203	2261	TST17	921203	IM240.1st	0.96	6.4	4.17	0.74	5.9	4.37	0.71	6.3	0.41	3.6	4.61
3204	2280	TST17	921203	IM240.2nd	0.34	6.4	0.47	0.16	4.1	0.45	0.15	3.4	0.15	3.3	0.57
3205	2302	TST17	921204	IM240.2nd	0.33	5.6	0.89	0.17	4.1	0.9	0.16	4.2	0.28	4.6	1.57
3206	2317	TST17	921207	IM240.1st	0.51	10.2	0.34	0.28	5.4	0.58	0.26	6.2	0.29	8.2	0.57
3207	2319	TST17	921207	IM240.1st	3.33	87.3	0.92	3.22	77.3	0.97	3.19	79.3	2.19	70.8	1.04
3208	2324	TST17	921207	IM240.2nd	2.38	113.4	0.31	1.87	74.4	0.41	1.83	71.9	1.59	73.7	0.73
3209	2326	TST17	921207	IM240.2nd	0.2	2.5	0.53	0.11	2.1	0.6	0.12	2.6	0.17	4.3	0.67
3210	2337	TST17	921207	IM240.1st	1.4	20.3	1.21	1.04	13.0	2.98	0.9	13.2	0.55	7.2	3.65
3211	2330	TST17	921207	IM240.2nd	0.48	10.8	0.57	1.42	93.1	0.53	1.94	129.3	0.63	64.9	0.58
3212	2352	TST17	921208	IM240.2nd	0.37	3.9	1.11	0.15	1.5	5.15	0.15	1.7	0.26	4.7	4.04
3213	2368	TST17	921208	IM240.2nd	0.33	4.3	0.93	0.54	19.6	1.17	0.59	24.7	0.16	3.0	0.55
3214	2369	TST17	921208	IM240.1st	1.15	12.9	2.5	2.01	23.4	2.96	1.83	21.4	0.85	6.6	2.03
3216	2379	TST17	921210	IM240.1st	0.3	3.2	0.65	0.96	14.8	1.04	0.12	0.9	0.47	7.1	0.55
3217	2376	TST17	921209	IM240.2nd	0.8	9.7	2.02	0.53	6.5	2.22	0.54	7.4	0.31	4.5	2.06
3218	2419	TST17	921210	IM240.1st	0.2	2.7	0.3	0.1	1.2	0.87	0.08	1.0	0.33	3.3	0.72
3219	2416	TST17	921210	IM240.2nd	0.33	4.0	0.78	0.23	4.0	0.81	0.2	3.1	0.38	4.0	0.89
3220	2424	TST17	921210	IM240.2nd	1.22	12.9	1.56	1.05	13.3	1.78	0.95	14.1	1.05	6.9	1.99
3221	2451	TST17	921211	IM240.2nd	0.39	4.5	0.57	0.35	4.0	0.8	0.27	3.5	0.36	3.6	0.60
3222	2435	TST17	921211	IM240.1st	0.32	4.7	0.64	0.15	3.0	1	0.09	2.1	0.77	3.2	0.76

Vehicle Information					FTP Scores			IM240 SCORES					ASM		
								Composites			Bag 2 score		Composite Scores		
Veh#	Run#	Test	Date	Order	HC	CO	NOx	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
3223	2440	TST17	921211	IM240.2nd	0.53	4.4	0.93	0.37	4.3	1.16	0.35	4.1	0.48	4.1	1.03
3224	2441	TST17	921215	IM240.1st	1.8	21.4	3.23	1.15	10.3	4.47	0.93	9.5	2.36	18.9	3.28
3225	2446	TST17	921214	IM240.2nd	0.57	5.7	0.77	0.19	7.9	1.33	0.18	6.3	0.76	8.3	1.07
3226	2447	TST17	921214	IM240.1st	0.31	3.7	0.99	0.19	3.2	1.59	0.18	3.1	0.30	4.3	1.44
3227	2449	TST17	921214	IM240.1st	0.42	7.6	1.25	0.23	1.4	1.82	0.15	1.2	0.37	3.2	0.80
3228	2450	TST17	921214	IM240.2nd	0.44	19.9	0.8	0.09	3.4	0.61	0.09	2.7	0.29	3.9	0.62
3229	2453	TST17	921214	IM240.1st	0.3	4.4	0.43	0.11	2.7	0.88	0.07	2.9	0.29	3.0	0.76
3230	2445	TST17	921215	IM240.1st	0.41	4.0	0.12	1.04	8.2	0.78	0.41	6.8	0.74	4.5	0.34
3231	2463	TST17	921216	IM240.1st	0.04	3.7	0.2	0.11	1.4	0.25	0.09	1.5	0.19	3.2	0.38
3232	2464	TST17	921216	IM240.2nd	0.18	3.2	0.18	0.33	11.3	0.75	0.44	15.4	0.34	12.8	0.84
3233	2469	TST17	921216	IM240.1st	0.24	2.0	0.28	0.13	1.2	0.21	0.09	0.5	0.26	2.9	0.34
3234	2470	TST17	921216	IM240.2nd	0.25	2.9	0.94	0.16	2.6	1.41	0.17	2.5	0.27	3.4	1.19
3235	2479	TST17	921217	IM240.1st	0.38	2.4	0.34	0.82	6.4	1.8	0.5	5.0	0.70	4.1	0.93
3236	2483	TST17	921217	IM240.1st	0.73	8.6	1.84	1.04	13.9	4.01	1.06	14.6	0.56	5.5	3.03
3237	2488	TST17	921217	IM240.2nd	0.33	3.0	0.28	0.22	2.3	0.19	0.14	1.3	0.31	3.4	0.35
3238	2489	TST17	921217	IM240.1st	0.35	2.3	0.35	0.27	4.7	0.43	0.23	5.3	0.39	3.7	0.40
3239	2490	TST17	921217	IM240.2nd	0.24	1.5	0.72	0.03	0.5	2.4	0.02	0.1	0.28	3.0	1.07
3240	2492	TST17	921217	IM240.2nd	0.27	2.7	1.14	0.07	1.5	2.55	0.06	1.2	0.20	3.0	2.55
3241	2496	TST17	921218	IM240.2nd	0.3	5.5	0.83	0.19	3.4	1.11	0.11	1.8	0.16	3.0	0.87
3242	2499	TST17	921218	IM240.1st	0.39	5.8	1.91	1.05	13.7	3.34	0.71	9.2	0.16	3.7	0.98
3243	2507	TST17	921218	IM240.1st	0.67	8.5	2.18	0.81	7.6	3.38	0.55	6.9	0.40	5.5	2.58
3244	2516	TST17	921218	IM240.2nd	0.22	3.1	0.47	0.09	3.5	2.34	0.09	3.9	0.16	3.8	2.39
3245	2529	TST17	921218	IM240.1st	0.56	4.7	1.63	0.49	4.2	4.52	0.48	4.4	0.19	3.6	1.99
3246	2563	TST17	921221	IM240.2nd	0.33	8.6	1.29	0.42	11.1	2.02	0.52	12.0	0.50	5.4	2.08
3247	2548	TST17	921221	IM240.2nd	0.84	11.4	1.99	0.69	13.5	3.78	0.6	13.1	0.53	6.5	3.09
3248	2830	TST17	930112	IM240.2nd	0.39	3.3	1.51	0.21	2.5	2.55	0.15	2.1	0.15	3.1	2.05
3249	2835	TST17	930112	IM240.1st	0.2	3.8	2.25	0.15	4.6	3.56	0.15	4.9	0.12	4.0	1.97
3250	2845	TST17	930113	IM240.1st	1.55	5.1	1.06	1.57	8.0	1.38	1.27	5.9	0.93	2.9	1.09
3251	2914	TST17	930114	IM240.2nd	1.31	16.9	4.26	0.25	3.6	5.25	0.25	4.2	0.59	5.8	3.46
3252	2945	TST17	930114	IM240.1st	1.03	12.5	1.34	0.99	8.8	1.76	0.85	8.5	0.96	8.4	1.69
3254	3080	TST17	930128	IM240.2nd	1.87	35.9	1.16	2.26	28.6	1.5	2	31.6	0.34	6.3	0.99
3255	3174	TST17	930129	IM240.2nd	0.18	1.3	0.23	0.1	0.8	0.14	0.12	0.9	0.16	3.1	0.38
3256	3208	TST17	930202	IM240.2nd	0.23	2.5	0.26	0.1	0.7	0.19	0.12	0.8	0.25	3.2	0.42

Vehicle Information					FTP Scores			IM240 SCORES					ASM		
								Composites			Bag 2 score		Composite Scores		
Veh#	Run#	Test	Date	Order	HC	CO	NOx	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
3257	3213	TST17	930202	IM240.1st	1.26	8.6	0.9	1.92	10.6	1.55	1.48	9.4	0.27	4.6	1.03
3259	3250	TST17	930209	IM240.2nd	1.94	15.0	0.53	1.5	9.3	0.88	1.15	8.3	0.26	4.6	1.22
3260	3438	TST17	930216	IM240.2nd	0.2	3.0	0.66	0.11	3.4	0.85	0.12	3.7	0.23	3.0	1.46
3261	3475	TST17	930216	IM240.1st	0.72	12.5	0.37	0.91	19.1	0.69	0.79	19.3	0.48	11.8	0.76
3262	3480	TST17	930217	IM240.2nd	0.34	3.7	1.88	0.19	3.7	2.26	0.17	3.4	0.16	3.3	1.56
3264	3519	TST17	930218	IM240.1st	1.36	20.3	1.06	2.16	20.1	1.65	1.44	16.0	0.54	5.6	1.55
3265	3530	TST17	930223	IM240.2nd	2.7	14.8	2.59	2.49	9.9	3.32	2.22	9.1	1.81	5.5	2.84

Vehicle Information					FTP Scores			IM240 SCORES					ASM		
								Composites			Bag 2 score		Composite Scores		
Veh#	Run#	Test	Date	Order	HC	CO	NOx	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
3150	1692	TST17	921028	IM240.2nd	2.43	82.9	0.59	1.44	32.6	0.95	0.79	14.7	1.35	86.9	0.62
3150	1924	TST2	921113	IM240.2nd	0.45	7.6	0.95	0.19	2.8	1.40	0.21	3.2	0.18	3.4	0.95
3151	1696	TST17	921028	IM240.2nd	0.34	3.5	5.81	0.20	2.0	4.52	0.10	2.7	0.36	3.6	3.19
3151	2145	TST27	921123	IM240.2nd	0.28	3.3	0.88	0.14	7.4	0.87	0.16	10.3	0.09	2.9	0.66
3154	1739	TST17	921030	IM240.1st	0.31	6.2	1.04	0.34	4.4	2.24	0.23	3.4	0.24	7.3	1.46
3154	1923	TST2	921113	IM240.1st	0.30	5.2	1.15	0.32	4.7	1.59	0.23	3.7	0.23	5.4	1.87
3155	1735	TST17	921030	IM240.1st	3.25	46.7	0.26	2.77	24.1	1.20	2.06	17.2	0.34	6.0	0.50
3155	1901	TST2	921106	IM240.1st	0.35	3.3	0.37	0.30	4.5	0.75	0.37	5.8	0.22	4.9	0.66
3156	1726	TST17	921029	IM240.2nd	0.31	6.7	1.07	0.45	6.1	2.07	0.45	6.2	0.15	3.7	1.04
3156	1926	TST2	921113	IM240.2nd	0.27	7.0	1.12	0.16	4.5	1.16	0.12	4.1	0.15	3.5	1.12
3157	1747	TST17	921030	IM240.1st	1.70	14.3	2.14	2.84	34.7	2.95	2.26	15.7	0.95	11.1	2.56
3157	2025	TST2	921118	IM240.1st	0.24	2.4	0.53	0.04	1.3	0.28	0.05	1.4	0.13	2.9	0.61
3159	1752	TST17	921030	IM240.2nd	1.11	74.2	0.31	0.74	40.3	0.48	0.83	49.2	0.48	32.9	0.88
3159	2032	TST2	921118	IM240.2nd	0.28	7.6	0.13	0.12	4.6	0.14	0.10	4.4	0.13	5.3	0.39
3160	1749	TST17	921030	IM240.1st	0.29	3.0	1.26	0.21	2.8	2.26	0.18	2.6	0.13	3.4	1.31
3160	1925	TST2	921113	IM240.1st	0.30	3.7	1.49	0.16	1.4	1.87	0.15	1.6	0.19	6.8	1.98
3165	1810	TST17	921103	IM240.2nd	1.96	13.2	2.50	1.58	7.3	2.48	1.50	6.9	0.39	5.6	1.50
3165	2141	TST27	921123	IM240.2nd	0.29	1.3	0.98	0.08	0.4	0.96	0.09	0.5	0.09	3.0	1.01
3169	1677	TST17	921027	IM240.1st	1.04	15.0	0.96	0.85	14.1	0.97	0.79	14.7	0.57	16.7	0.68
3169	1927	TST2	921113	IM240.1st	0.34	1.3	1.81	0.27	0.5	1.43	0.23	0.5	0.26	5.7	1.04
3172	1895	TST18	921106	IM240.1st	0.16	3.3	0.73	0.13	2.1	3.30	0.09	1.8	0.11	3.3	0.51
3172	2335	TST2	921203	IM240.1st	0.15	2.0	0.52	0.04	0.8	0.44	0.05	0.7	0.09	3.2	0.41
3174	1688	TST17	921028	IM240.2nd	0.74	16.3	1.88	0.76	19.3	2.50	0.62	16.6	0.20	9.0	1.81
3174	2174	TST2	921124	IM240.2nd	0.19	4.6	1.06	0.14	6.6	1.37	0.08	3.4	0.08	3.1	1.18

Vehicle Information					FTP Scores			IM240 SCORES					ASM		
								Composites			Bag 2 score		Composite Scores		
Veh#	Run#	Test	Date	Order	HC	CO	NOx	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
3175	1907	TST17	921106	IM240.1st	0.40	13.1	0.46	0.90	47.8	0.63	1.04	59.7	0.17	12.9	0.84
3175	2364	TST2	921204	IM240.1st	0.42	7.9	0.71	0.43	9.6	0.60	0.48	12.0	0.08	4.1	0.54
3179	1966	TST17	921116	IM240.2nd	2.90	77.6	2.06	1.84	55.9	1.60	1.71	54.3	1.48	89.0	2.10
3179	2206	TST2	921125	IM240.2nd	0.22	4.1	1.18	0.07	2.1	1.37	0.09	2.7	0.13	3.0	1.53
3180	2005	TST17	921118	IM240.1st	0.96	9.8	1.22	1.33	8.5	2.34	1.09	5.9	0.15	3.6	0.68
3180	2433	TST27	921209	IM240.1st	0.69	8.8	0.74	0.57	4.8	1.12	0.30	3.7	0.36	3.8	0.84
3183	2024	TST17	921118	IM240.2nd	3.13	66.3	0.70	1.29	26.0	0.85	1.01	20.6	1.11	35.3	1.59
3183	2288	TST2	921201	IM240.2nd	0.25	3.2	1.21	0.17	8.1	1.13	0.20	10.9	0.10	3.1	1.26
3188	2160	TST17	921124	IM240.2nd	4.49	17.8	0.20	4.02	14.4	0.10	3.21	14.2	3.61	18.2	0.32
3188	2382	TST27	921207	IM240.2nd	0.63	5.1	0.54	0.13	2.7	0.66	0.11	2.7	0.16	3.5	0.76
3190	2161	TST17	921124	IM240.1st	13.07	42.0	0.56	7.06	24.8	0.79	5.77	23.1	3.70	12.8	0.80
3190	2456	TST27	921210	IM240.1st	0.19	0.6	0.82	0.10	2.7	0.66	0.10	3.6	0.19	2.9	0.68
3196	2230	TST17	921127	IM240.2nd	2.87	26.5	5.81	2.73	13.9	5.10	2.55	13.6	1.21	15.8	5.88
3196	2511	TST27	921214	IM240.2nd	0.34	1.2	0.83	0.16	1.1	0.94	0.17	1.3	0.16	2.9	1.15
3197	2238	TST17	921127	IM240.2nd	1.29	3.5	2.42	0.99	8.3	2.66	0.88	8.7	0.60	7.8	2.97
3197	2432	TST27	921208	IM240.2nd	0.14	1.7	0.22	0.00	0.3	0.07	0.00	0.3	0.21	3.1	0.30
3198	2198	TST17	921125	IM240.2nd	1.77	10.2	1.80	1.51	8.5	2.04	1.31	8.2	0.86	7.4	2.50
3198	2431	TST27	921208	IM240.2nd	0.18	1.9	0.05	0.05	0.8	0.03	0.06	1.1	0.32	4.6	0.29
3200	2245	TST17	921128	IM240.1st	0.59	0.3	0.69	0.29	1.6	2.47	0.27	1.5	0.13	2.9	1.58
3200	2457	TST27	921210	IM240.1st	0.62	1.6	0.42	0.44	0.3	0.80	0.38	0.3	0.45	2.9	0.53
3201	2237	TST17	921127	IM240.1st	0.94	19.7	1.72	1.15	8.8	1.82	0.52	6.0	0.17	4.7	1.22
3201	2388	TST27	921207	IM240.1st	0.47	4.1	1.11	0.49	5.8	1.11	0.31	3.7	0.27	4.4	0.77
3202	2273	TST17	921201	IM240.1st	0.50	7.5	7.56	0.23	3.6	7.88	0.20	3.2	0.18	3.2	8.60
3202	2487	TST27	921211	IM240.1st	0.42	7.1	1.25	0.25	7.2	1.66	0.25	8.8	0.31	4.1	1.16

Vehicle Information					FTP Scores			IM240 SCORES					ASM		
								Composites			Bag 2 score		Composite Scores		
Veh#	Run#	Test	Date	Order	HC	CO	NOx	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
3203	2261	TST17	921130	IM240.1st	0.96	6.4	4.17	0.74	5.9	4.37	0.71	6.3	0.27	3.4	3.52
3203	2569	TST2	921217	IM240.1st	0.75	5.7	1.30	0.87	11.1	1.32	0.82	13.6	0.47	3.9	1.49
3207	2319	TST17	921203	IM240.1st	3.33	87.3	0.92	3.20	76.9	0.97	3.19	79.3	1.50	70.8	1.04
3207	2459	TST27	921210	IM240.1st	0.44	2.7	1.11	0.29	2.0	1.35	0.35	2.0	0.41	3.4	1.31
3208	2324	TST17	921203	IM240.2nd	2.38	113.4	0.31	1.86	74.3	0.41	1.83	71.9	1.24	73.7	0.73
3208	2468	TST27	921211	IM240.2nd	0.22	1.7	0.96	0.02	0.9	0.61	0.02	0.7	0.22	2.9	0.62
3210	2337	TST17	921203	IM240.1st	1.40	20.3	1.21	1.03	12.9	2.97	0.90	13.2	0.35	6.6	3.17
3210	2643	TST2	921222	IM240.1st	0.34	1.2	0.34	0.12	0.5	0.12	0.10	0.5	0.29	3.5	0.38
3211	2330	TST17	921203	IM240.2nd	0.48	10.8	0.57	1.42	93.1	0.53	1.94	129.3	0.67	75.2	0.63
3211	2461	TST27	921210	IM240.2nd	0.38	2.8	0.50	0.04	1.4	0.83	0.02	0.7	0.71	68.9	0.43
3212	2352	TST17	921204	IM240.2nd	0.37	3.9	1.11	0.15	1.5	5.15	0.15	1.7	0.24	4.7	4.04
3212	2494	TST27	921212	IM240.2nd	0.33	3.7	1.05	0.14	2.9	0.83	0.13	2.8	0.14	3.3	0.93
3213	2368	TST17	921205	IM240.2nd	0.33	4.3	0.93	0.54	19.6	1.17	0.59	24.7	0.14	3.0	0.55
3213	2493	TST27	921212	IM240.2nd	0.30	4.1	0.78	0.13	1.1	1.03	0.12	1.3	0.18	2.9	0.66
3214	2369	TST17	921205	IM240.1st	1.15	12.9	2.50	2.00	23.2	2.94	1.83	21.4	0.69	6.6	2.03
3214	2518	TST27	921214	IM240.1st	0.15	1.6	0.32	0.11	1.2	0.39	0.09	0.9	0.20	3.1	0.51
3217	2376	TST17	921205	IM240.2nd	0.80	9.7	2.02	0.53	6.5	2.22	0.54	7.4	0.23	4.2	1.80
3217	2515	TST27	921214	IM240.2nd	0.67	8.7	1.36	0.79	18.9	1.54	0.89	24.7	0.28	3.9	1.71
3220	2424	TST17	921208	IM240.2nd	1.22	12.9	1.56	1.05	13.3	1.78	0.95	14.0	0.73	6.3	1.70
3220	2570	TST2	921217	IM240.2nd	0.24	1.6	0.57	0.03	0.5	0.44	0.03	0.6	0.12	2.9	0.48
3224	2441	TST17	921209	IM240.1st	1.80	21.4	3.23	1.15	10.3	4.47	0.93	9.5	1.03	16.4	3.28
3224	2680	TST2	921224	IM240.1st	0.20	1.4	0.36	0.04	1.0	0.06	0.05	1.0	0.20	3.1	0.29
3236	2483	TST17	921211	IM240.1st	0.73	8.6	1.84	1.04	13.9	4.01	1.06	14.6	0.47	5.5	3.03
3236	2608	TST2	921221	IM240.1st	0.15	2.6	0.53	0.08	1.7	0.66	0.08	1.5	0.16	3.0	0.99

Vehicle Information					FTP Scores			IM240 SCORES Composites			IM240 SCORES Bag 2 score		ASM Composite Scores		
Veh#	Run#	Test	Date	Order	HC	CO	NOx	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
3239	2490	TST17	921211	IM240.2nd	0.24	1.5	0.72	0.03	0.5	2.40	0.02	0.1	0.20	3.0	1.07
3239	2646	TST2	921222	IM240.2nd	0.30	1.0	0.85	0.07	1.4	0.96	0.02	0.4	0.28	2.9	0.84
3240	2492	TST17	921212	IM240.2nd	0.27	2.7	1.14	0.07	1.5	2.52	0.06	1.2	0.16	3.0	2.55
3240	2678	TST2	921224	IM240.2nd	0.26	2.6	1.23	0.15	5.4	1.18	0.17	6.6	0.17	3.1	1.30
3242	2499	TST17	921214	IM240.1st	0.39	5.8	1.91	1.05	13.7	3.34	0.71	9.2	0.15	3.7	0.98
3242	2663	TST2	921223	IM240.1st	0.15	1.4	0.38	0.15	6.7	0.51	0.18	9.0	0.18	3.2	0.40
3243	2507	TST17	921214	IM240.1st	0.67	8.5	2.18	0.81	7.6	3.38	0.55	6.9	0.33	5.5	2.58
3243	2670	TST2	921223	IM240.1st	0.21	1.8	0.27	0.24	4.0	0.42	0.20	4.1	0.32	3.7	0.44
3244	2516	TST17	921214	IM240.2nd	0.22	3.1	0.47	0.09	3.5	2.34	0.09	3.9	0.13	3.8	2.39
3244	2671	TST2	921223	IM240.2nd	0.25	3.8	0.42	0.11	5.3	0.38	0.11	5.7	0.29	3.7	0.52
3245	2529	TST17	921215	IM240.1st	0.56	4.7	1.63	0.49	4.2	4.52	0.48	4.4	0.13	3.6	1.99
3245	2679	TST2	921224	IM240.1st	0.11	0.6	0.35	0.04	0.4	0.31	0.03	0.4	0.15	3.0	0.42
3247	2548	TST17	921216	IM240.2nd	0.84	11.4	1.99	0.69	13.5	3.78	0.60	13.1	0.47	7.2	3.66
3247	2681	TST2	921224	IM240.2nd	0.12	0.8	0.35	0.04	0.7	0.25	0.03	0.6	0.21	3.1	0.36
3248	2830	TST17	930106	IM240.2nd	0.39	3.3	1.51	0.21	2.5	2.53	0.15	2.1	0.13	3.1	2.05
3248	3105	TST27	930121	IM240.2nd	0.27	1.5	0.33	0.03	1.3	0.20	0.03	1.2	0.11	2.9	0.50
3249	2835	TST17	930107	IM240.1st	0.20	3.8	2.25	0.15	4.5	3.51	0.15	4.9	0.10	4.0	1.97
3249	3056	TST27	930119	IM240.1st	0.18	1.6	0.69	0.16	4.0	0.89	0.19	4.9	0.12	3.3	0.96
3250	2845	TST17	930107	IM240.1st	1.55	5.1	1.06	1.52	7.8	1.35	1.26	5.9	0.63	2.9	1.09
3250	3183	TST27	930127	IM240.1st	0.68	1.5	1.20	0.25	0.2	1.37	0.21	0.2	0.30	2.9	1.06
3252	2945	TST17	930113	IM240.1st	1.03	12.5	1.34	0.99	8.8	1.76	0.85	8.4	0.52	8.4	1.69
3252	3192	TST27	930127	IM240.1st	0.12	1.1	0.17	0.13	1.5	0.27	0.12	1.9	0.20	4.0	0.52
3257	3213	TST17	930128	IM240.1st	1.26	8.6	0.90	1.92	10.6	1.55	1.48	9.4	0.25	4.6	1.03
3257	3637	TST27	930225	IM240.1st	0.70	3.9	0.26	0.48	2.5	0.11	0.55	2.7	0.29	3.8	0.31

Vehicle Information					FTP Scores			IM240 SCORES					ASM		
								Composites			Bag 2 score		Composite Scores		
Veh#	Run#	Test	Date	Order	HC	CO	NOx	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
3259	3250	TST17	930201	IM240.2nd	1.94	15.0	0.53	1.50	9.3	0.88	1.15	8.3	0.23	4.6	1.22
3259	3518	TST2	930217	IM240.2nd	0.23	3.5	0.74	0.11	2.0	0.95	0.10	1.8	0.22	3.4	0.96
3261	3475	TST17	930212	IM240.1st	0.72	12.5	0.37	0.91	19.1	0.68	0.79	19.3	0.34	11.8	0.76
3261	3581	TST2	930222	IM240.1st	0.60	8.1	0.79	0.45	11.5	0.79	0.41	12.4	0.18	3.4	0.63
3264	3519	TST17	930217	IM240.1st	1.36	20.3	1.06	2.16	20.1	1.66	1.44	16.0	0.49	5.6	1.55
3264	3671	TST29	930226	IM240.1st	0.49	4.9	1.05	0.33	3.7	0.96	0.23	3.3	0.13	3.3	1.20
3265	3530	TST17	930217	IM240.2nd	2.70	14.8	2.59	2.49	9.9	3.31	2.21	9.1	1.22	5.5	2.84
3265	3704	TST27	930310	IM240.2nd	0.10	0.7	0.11	0.01	0.4	0.07	0.01	0.3	0.10	2.9	0.26

Vehicle Information						Arizona I/M Test				IM240 Scores					ASM Composite Scores		
						Loaded Mode		Idle Mode		Composite			Bag 2 Score				
CR#	Veh#	Run#	Test	Date	Order	HC	CO	HC	CO	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
1	11898	1898	TST17	921106	IM240.2nd	70	2.15	26	0.18	1.00	55.1	0.48	1.28	66.60	0.68	49.8	0.56
1	11898	1906	TST19	921106	IM240.2nd	116	2.97	43	0.09	0.59	33.3	0.63	0.71	36.40	0.23	8.2	0.60
1	11898	2012	TST20	921118	IM240.2nd	1	0	1	0	0.09	5.7	0.42	0.11	7.80	0.17	3.4	0.37
2	12636	2636	TST17	921222	IM240.2nd	70	0.02	545	0.11	0.36	1.6	2.45	0.30	2.10	0.41	3.1	2.17
2	12636	2662	TST19	921223	IM240.2nd	39	0.02	140	0.02	0.27	1.7	1.78	0.21	2.20	0.16	2.9	1.71
3	12644	2644	TST17	921222	IM240.2nd	260	6.88	45	0.01	2.69	140.9	0.11	2.75	144.80	1.66	112.0	0.35
3	12644	2720	TST19	921230	IM240.2nd	14	0	13	0	1.21	79.6	0.20	1.36	92.10	0.51	56.0	0.33
8	12771	2771	TST17	930104	IM240.1st	86	1.55	87	0.38	1.51	12.2	2.86	1.32	9.50	0.46	5.7	2.19
8	12771	2977	TST19	930114	IM240.1st	38	0.63	835	0.07	1.38	4.1	2.59	1.16	4.30	0.33	3.5	1.63
8	12771	3168	TST20	930126	IM240.1st	75	0.38	41	0.06	1.01	4.4	3.01	0.91	4.30	0.16	3.4	1.51
6	12794	2794	TST17	930105	IM240.2nd	51	0.11	455	7.03	2.43	80.2	0.50	2.68	99.80	1.41	51.9	0.68
6	12794	2975	TST19	930114	IM240.1st	298	10	480	7.21	2.09	72.5	0.39	2.19	86.50	1.27	61.0	0.49
6	12794	3137	TST20	930125	IM240.1st	46	0.15	106	1.44	1.55	55.8	0.47	1.69	68.00	0.40	24.4	0.57
10	12798	2798	TST17	930105	IM240.2nd	279	2.53	152	2.29	3.64	64.6	1.41	3.54	65.60	1.62	46.8	1.18
10	12798	3049	TST19	930119	IM240.1st	229	0.54	122	0.06	2.36	20.1	2.08	2.32	23.50	1.15	15.9	1.59
10	12798	3064	TST20	930119	IM240.2nd	100	0.15	141	0.29	2.14	35.8	1.13	1.72	34.60	0.28	6.9	0.89
4	12853	2853	TST17	930107	IM240.1st	201	4.33	637	7.41	2.08	52.3	0.28	2.02	56.60	1.29	52.5	0.63
4	12853	2861	TST19	930108	IM240.1st	81	0.95	12	0	0.90	27.9	0.36	0.91	29.50	0.54	20.4	0.55
5	12863	2863	TST17	930108	IM240.1st	433	8.72	1540	10	5.86	164.3	0.72	5.58	170.30	3.65	160.2	0.62
5	12863	2901	TST19	930111	IM240.1st	7	0	10	0	0.25	2.8	1.76	0.14	2.80	0.17	3.2	0.97
7	12968	2968	TST17	930113	IM240.2nd	397	1.58	466	1.79	6.00	37.0	1.19	5.10	35.30	2.45	23.3	1.02
7	12968	2976	TST19	930114	IM240.2nd	177	2.16	427	0.83	5.69	29.7	1.22	4.85	28.40	2.14	16.3	0.97
9	12981	2981	TST17	930114	IM240.1st	108	1.46	27	0.03	1.46	15.0	3.71	1.31	12.50	0.78	9.1	2.20
9	12981	2988	TST19	930114	IM240.1st	78	0.37	43	0.14	1.20	7.9	3.88	1.12	8.10	0.62	4.1	2.75

Vehicle Information						Arizona I/M Test				IM240 Scores					ASM Composite Scores		
						Loaded Mode		Idle Mode		Composite			Bag 2 Score				
CR#	Veh#	Run#	Test	Date	Order	HC	CO	HC	CO	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
11	13084	3084	TST17	930120	IM240.2nd	15	0.02	1517	0.01	1.16	7.8	0.20	1.13	7.50	0.19	3.0	0.35
11	13084	3104	TST19	930121	IM240.2nd	13	0	370	4.7	0.12	2.2	0.60	0.09	1.90	0.30	3.5	0.83
14	13124	3124	TST17	930122	IM240.2nd	111	1.42	17	0	0.41	11.1	0.52	0.44	12.80	0.29	7.8	1.04
14	13124	3181	TST19	930127	IM240.2nd	6	0.01	12	0	0.13	2.4	1.44	0.14	2.80	0.28	3.2	2.45
12	13125	3125	TST17	930122	IM240.1st	110	0.34	853	0.09	1.06	10.7	1.77	0.93	9.70	0.48	4.3	1.21
12	13125	3129	TST19	930122	IM240.1st	74	0.41	16	0	1.08	15.1	1.26	0.81	10.60	0.29	3.5	0.82
13	13146	3146	TST17	930126	IM240.2nd	117	1.91	84	0.14	3.25	50.7	1.51	2.87	46.50	1.03	42.2	1.64
13	13146	3156	TST19	930126	IM240.2nd	40	0.16	26	0	0.80	13.5	0.89	0.66	11.40	0.38	6.2	0.96
15	13202	3202	TST17	930128	IM240.2nd	129	0.97	712	10	1.33	16.8	3.50	1.22	8.40	0.62	6.3	3.32
15	13202	3231	TST19	930129	IM240.1st	112	0.36	178	0.63	1.11	6.3	3.55	1.08	6.00	0.52	5.4	3.16
21	13263	3263	TST17	930201	IM240.1st	172	0.99	673	2.49	6.02	21.4	1.68	5.42	20.00	1.52	12.8	1.01
21	13263	3379	TST19	930205	IM240.1st	93	0.5	601	0.75	5.74	17.5	1.65	5.20	16.10	1.01	9.2	1.15
21	13263	3561	TST20	930219	IM240.1st	303	1.24	46	0.02	5.87	25.5	1.69	5.35	23.60	1.71	16.3	1.08
16	13306	3306	TST17	930203	IM240.2nd	191	0.45	428	1.84	3.42	19.6	4.25	2.89	16.00	1.35	4.8	3.16
16	13306	3310	TST19	930203	IM240.2nd	73	0.26	75	0.58	1.34	4.9	2.40	1.24	3.60	0.61	4.0	1.72
22	13349	3349	TST17	930204	IM240.1st	251	8.68	115	3.28	5.88	162.5	0.20	5.22	141.30	1.90	100.4	0.39
22	13349	3381	TST19	930205	IM240.1st	194	6.97	125	3.22	4.85	145.7	0.25	4.25	121.10	1.12	73.2	0.38
22	13349	3453	TST20	930211	IM240.1st	71	1.89	54	0.36	1.84	25.9	1.13	1.48	22.90	0.45	17.8	0.77
22	13349	3548	TST21	930218	IM240.1st	261	9.51	185	3.89	8.48	224.2	0.12	7.44	199.50	1.89	118.2	0.32
23	13375	3375	TST17	930205	IM240.1st	136	0.38	132	2.81	0.09	1.2	0.78	0.07	1.00	0.20	3.5	0.45
23	13375	3388	TST19	930208	IM240.2nd	7	0	2	0	0.03	0.3	0.84	0.02	0.30	0.22	3.7	0.53
27	13471	3471	TST17	930212	IM240.1st	10	1.61	1	0	0.24	35.0	0.21	0.22	37.00	0.14	7.2	0.34
27	13471	3757	TST19	930316	IM240.1st	12	0.01	4	0	0.17	3.3	1.33	0.17	4.50	0.18	3.1	0.45

Vehicle Information						Arizona I/M Test				IM240 Scores					ASM		
						Loaded Mode		Idle Mode		Composite			Bag 2 Score		Composite Scores		
CR#	Veh#	Run#	Test	Date	Order	HC	CO	HC	CO	HC	CO	NOx	HC2	CO2	ASM HC	ASM CO	ASM NOx
25	13504	3504	TST17	930216	IM240.2nd	49	0.01	150	3.02	0.41	6.7	5.73	0.33	4.30	0.31	19.3	4.44
25	13504	3511	TST19	930216	IM240.1st	23	0	5	0	0.13	0.2	5.04	0.13	0.20	0.19	2.9	3.54
26	13616	3616	TST17	930224	IM240.2nd	189	0.19	349	10	2.77	44.8	0.37	2.58	37.30	0.50	18.7	0.41
26	13616	3680	TST19	930301	IM240.2nd	25	0.04	11	0	0.22	3.9	1.15	0.18	3.80	0.38	3.9	1.16

TST17 - Initial Test
TST19 - After 1st Repair
TST20 - After 2nd Repair
TST21 - After 3rd Repair

Appendix C:

QC Steps for ASM Analysis Database

The Phoenix lane data used in these analyses were reported to EPA by the testing contractor as total values (concentrations, mass, or flow) for the entire test mode as well as in second-by-second form. The following automated quality control (QC) checks were performed by EPA on the data. Tests that were flagged by one (or more) of these QC checks were then manually verified.

Second by Second ASM Tolerance Checks:

- Speed Tolerance - ± 15% of nominal speed for Modes 1,2,3. Allowed tolerance to be exceeded for less than 3 seconds in duration. Also checked Idle for Modes 4,5
- Mode Length - Checked to ensure that each mode contained at least 20 and not more than 30 "stable" seconds.
- Hp/Torque Tolerance - Compared required and actual horsepower (Hp) and Torque and flagged differences > ±10% for at least 5 seconds.

  All vehicles with test weights above 4000 pounds exceeded this tolerance because of the capacity of the dynamometer. These cars were not removed from these analyses. Smaller vehicles exceeding this tolerance were removed.
- Calculated average concentrations and cumulative purge for all ASM modes. Average concentrations were calculated as the average concentration from second 10 to second 39 of each mode. The first 10 seconds of each mode were ignored to allow for the dynamometer stabilization and exhaust transport time. Vehicles with less than 30 seconds per mode were noted and vehicles with less than 20 seconds per mode were excluded. Purge values were calculated as the total purge in liters over the entire ASM including transient accelerations.

Second by Second IM240 Tolerance Checks:

- Speed Tolerance - ± 4 mph at ± 1 sec of nominal speed. Allowed tolerance to be exceeded for less than 3 seconds in duration. Also speeds exceeding 70 mph, and less than 0 mph were flagged.
- Background Concentration Tolerances - Flagged background readings outside the following ranges:

  $1.8 < HC < 10.0$ (ppm)
  $-10.0 < CO < 30.0$ (ppm)
  $-0.5 < NO_x < 1.25$ (ppm)
  $0.0 < CO_2 < 0.15$ (percent)
- Test Length - Checked to ensure that the full 240 seconds were present.
- Distance Tolerance - Flagged distance > ± 5% of nominal distance

  Bag 1: 0.532 < dist 1 < 0.588
  Bag 2: 1.393 < dist 2 < 1.469

- Fuel Economy Tolerance - Flagged fuel economies < 10 mpg and >50 mpg

- Sample Continuity and Integrity - Ensured that the sampling was continuous (i.e., sec(I) = I for I = 1 to 240) and that gram and concentration values were non-zero (HC, CO and CO_2 cannot all be zero for fuel economy calculations or dilution factors).

  Non-zero concentrations were not mandatory for the Phoenix data because second by second concentrations received were calculated, not measured. The calculated concentrations were based on the reported grams per second results. These vehicles were still flagged for low concentrations but were not removed from the analyses for this reason.

- Comparison of c omposite and bag results calculated from the second by second data with composite and bags results received from ATL. Differences of > 10% were flagged.

Purge Flow Data QC

- Comparison of second-by-second purge flow to the reported cumulative purge flow and pass/fail status reported by ATL. All significant differences were flagged.

- Vehicles exhibiting a non-zero constant purge rate for more than 20 seconds and at various speeds were flagged. Purge data was rounded to nearest 0.01 liter/second prior to processing.

Bag FTP Tolerance Checks:

- The ratios of corresponding emissions (HC, CO, and NO_X) and fuel economy for each of the three bags that were not within expected ranges were flagged.

- The temperatures, barometric pressures, and distances that were not within expected ranges were flagged.

Bag IM240 Tolerance Checks:

- Bag-1 emissions (HC, CO, and NO_X) and fuel economy were compared to the corresponding Bag-2 results (based on regression analyses previously performed on the Indiana data). All significant differences were flagged.

- The Bag-1 and Bag-2 fuel economies were also compared to the test weight. All fuel economy values that were not within an expected range (based on test weight) were flagged.

- The Bag-1 and Bag-2 distances not with the following ranges were flagged:

Bag 1: $0.545 \le \text{dist } 1 \le 0.586$
Bag 2: $1.365 \le \text{dist } 2 \le 1.435$

Bag IM240/FTP Tolerance Checks:

- For the laboratory recruited vehicles, the composite IM240 emissions (HC, CO, and NO_X) and fuel economy were compared to the corresponding FTP results (based on regression analyses previously performed on the Indiana data). All significant differences were flagged.

Dynamometer Loading Tolerance Checks:

- The test weights and horsepower settings had to be within 10% for all tests performed on each vehicle.

Excluded Data Summary

This section of Appendix C details the vehicles excluded from the various databases.

Purge Analysis - 1725 of the 1758 lane tests contained the necessary data to be included into this analysis. Of these 153 were removed because of a malfunctioning purge meter, 184 tests were repeat tests for vehicles previously tested and were removed, 5 cars had purge flow status fields which indicated missing data, 95 additional vehicles had no indication of test order and were removed, and 118 of the remaining vehicles exhibited non-zero constant purge rates over varied vehicle speeds and were removed. The result was a database of 1170 lane tested vehicles.

Cutpoint Table Analysis - This analysis required laboratory FTP data. Therefore, only lab recruited vehicles were considered for this analysis. Of the 127 recruited vehicles, 17 did not receive initial ASM tests and one (veh# 3258) did not receive an as-received FTP. Of the remaining 109 vehicles one vehicle (veh# 2177) was removed because the ambient FTP temperature exceeded allowable tolerances, one vehicle (veh# 3253) was removed due to extremely low HC emissions at the lane caused by a flame-out in the FID HC analyzer, and veh# 3164 was removed due to unacceptable speed deviations on its initial ASM test. The resulting database contained 106 lab recruited vehicles.

Commercial Repair Analysis - Of the 27 vehicles recruited for this program only 23 had completed after repair tests at the time of this analysis. One vehicle, #13239 (CR# 24) was removed from the database due to unacceptable speed deviations on its initial ASM test, leaving 22 vehicles available for analysis. For the analysis of Section 5.6.2, 5 vehicles failed to pass the Arizona state test on the subsequent retest and were removed. The resulting database used for this analysis consisted of 17 vehicles which received "successful" commercial repairs. For the commercial repair analysis of Section 5.6.3, only vehicles initially failing ASM cutpoints were included. The result was 17 vehicles. Commercial repairs did not have to be successful for this analysis and the two data sets contained slightly different cars.

Regression Coefficient Analysis - For this analysis all lab recruited vehicles and commercial repair vehicles were removed from the analysis to prevent the application of coefficients to data used to develop those coefficients. Therefore, 1422 of the 1758 vehicles were considered for inclusion into this analysis. Ten vehicles were removed because the composite IM240 data was not available. The following vehicles were removed because there was insufficient second by second data to calculate composite IM240 results:

Run #	Reason for Removal
1027	Test has only 93 seconds
1855	Missing second by second
2231	Test has only 93 seconds
3066	Sampling Discontinuity
3077	Sampling Discontinuity
3079	Sampling Discontinuity
3081	Sampling Discontinuity

Of the 1405 remaining vehicles, 1192 passed all QC tolerances. Purge tolerances were not considered for this analysis. The following table lists the QC tolerances checks for which vehicles were removed from this analysis.

Tolerance Flagged	Number of Vehicles
ASM Speed	8
Short ASM Mode	2
ASM Horsepower	10
IM240 Speed	14
IM240 Fuel Economy	4
IM240 Background	163
IM240 Sample	18

Note: 1405 minus the above vehicles does not equal 1192 because some vehicles exceeded more than one tolerance

Six hundred and eight (608) of the 1192 tests remaining received the IM240 second and were chosen for this analysis.

Appendix D

IM240 Cutpoint Tables

Appendix D: IM240 Cutpoint Tables

IM240	Cutpoints	Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Composite + Mode 2	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
12%	l.20 / 20.0 / 2.5 + 0.75 / 16.(	343	5286	253	86.2%	61.5%	74.0%	257	0	0.0%	0	0.0%
13%	l.00 / 20.0 / 2.4 + 0.62 / 16.(	351	5419	262	88.2%	63.1%	76.5%	275	0	0.0%	0	0.0%
13%	l.00 / 20.0 / 2.5 + 0.62 / 16.(	348	5342	257	87.4%	62.2%	74.9%	263	0	0.0%	0	0.0%
13%	l.20 / 18.0 / 2.5 + 0.75 / 14.‹	347	5422	258	87.2%	63.1%	75.5%	275	0	0.0%	0	0.0%
13%	l.20 / 15.0 / 2.5 + 0.75 / 12.(	347	5422	258	87.2%	63.1%	75.5%	275	0	0.0%	0	0.0%
13%	l.20 / 20.0 / 2.4 + 0.75 / 16.(	347	5363	258	87.0%	62.4%	75.5%	269	0	0.0%	0	0.0%
14%	).80 / 20.0 / 2.5 + 0.50 / 16.(	362	5627	263	90.9%	65.5%	76.8%	293	0	0.0%	0	0.0%
14%	l.00 / 12.0 / 2.4 + 0.62 / 9.(	357	5548	262	89.6%	64.6%	76.5%	293	0	0.0%	0	0.0%
14%	l.20 / 12.0 / 2.4 + 0.75 / 9.(	357	5548	262	89.6%	64.6%	76.5%	293	0	0.0%	0	0.0%
14%	l.00 / 12.0 / 2.5 + 0.62 / 9.(	356	5548	262	89.3%	64.6%	76.5%	287	0	0.0%	0	0.0%
14%	l.20 / 12.0 / 2.5 + 0.75 / 9.(	356	5548	262	89.3%	64.6%	76.5%	287	0	0.0%	0	0.0%
14%	l.00 / 18.0 / 2.4 + 0.62 / 14.‹	353	5478	262	88.7%	63.8%	76.5%	287	0	0.0%	0	0.0%
14%	l.00 / 15.0 / 2.4 + 0.62 / 12.(	353	5478	262	88.7%	63.8%	76.5%	287	0	0.0%	0	0.0%
14%	l.00 / 18.0 / 2.5 + 0.62 / 14.‹	352	5478	262	88.4%	63.8%	76.5%	281	0	0.0%	0	0.0%
14%	l.00 / 15.0 / 2.5 + 0.62 / 12.(	352	5478	262	88.4%	63.8%	76.5%	281	0	0.0%	0	0.0%
14%	l.00 / 20.0 / 2.3 + 0.62 / 16.(	351	5429	266	88.2%	63.2%	77.7%	293	12	0.6%	0	0.6%
14%	l.20 / 18.0 / 2.3 + 0.75 / 14.‹	348	5432	263	87.4%	63.2%	76.7%	298	12	0.6%	0	0.6%
14%	l.20 / 15.0 / 2.3 + 0.75 / 12.(	348	5432	263	87.4%	63.2%	76.7%	298	12	0.6%	0	0.6%
14%	l.20 / 18.0 / 2.4 + 0.75 / 14.‹	348	5422	258	87.4%	63.1%	75.5%	281	0	0.0%	0	0.0%
14%	l.20 / 15.0 / 2.4 + 0.75 / 12.(	348	5422	258	87.4%	63.1%	75.5%	281	0	0.0%	0	0.0%
14%	l.20 / 20.0 / 2.3 + 0.75 / 16.(	347	5373	263	87.0%	62.6%	76.7%	287	12	0.6%	0	0.6%
15%	).60 / 20.0 / 2.4 + 0.37 / 16.(	365	5707	268	91.6%	66.5%	78.3%	316	6	0.3%	0	0.3%
15%	).80 / 20.0 / 2.4 + 0.50 / 16.(	365	5704	268	91.6%	66.4%	78.3%	304	0	0.0%	0	0.0%
15%	).80 / 18.0 / 2.4 + 0.50 / 14.‹	365	5709	268	91.6%	66.5%	78.3%	310	0	0.0%	0	0.0%
15%	).80 / 15.0 / 2.4 + 0.50 / 12.(	365	5709	268	91.6%	66.5%	78.3%	310	0	0.0%	0	0.0%
15%	).80 / 12.0 / 2.4 + 0.50 / 9.(	365	5709	268	91.6%	66.5%	78.3%	310	0	0.0%	0	0.0%
15%	).60 / 20.0 / 2.5 + 0.37 / 16.(	364	5707	268	91.3%	66.5%	78.3%	310	6	0.3%	0	0.3%
15%	).60 / 18.0 / 2.5 + 0.37 / 14.‹	364	5713	268	91.3%	66.5%	78.3%	316	6	0.3%	0	0.3%
15%	).80 / 18.0 / 2.5 + 0.50 / 14.‹	364	5709	268	91.3%	66.5%	78.3%	304	0	0.0%	0	0.0%
15%	).60 / 15.0 / 2.5 + 0.37 / 12.(	364	5713	268	91.3%	66.5%	78.3%	316	6	0.3%	0	0.3%
15%	).80 / 15.0 / 2.5 + 0.50 / 12.(	364	5709	268	91.3%	66.5%	78.3%	304	0	0.0%	0	0.0%
15%	).60 / 12.0 / 2.5 + 0.37 / 9.(	364	5713	268	91.3%	66.5%	78.3%	316	6	0.3%	0	0.3%
15%	).80 / 12.0 / 2.5 + 0.50 / 9.(	364	5709	268	91.3%	66.5%	78.3%	304	0	0.0%	0	0.0%
15%	l.00 / 12.0 / 2.3 + 0.62 / 9.(	357	5558	266	89.6%	64.7%	77.7%	310	12	0.6%	0	0.6%
15%	l.20 / 12.0 / 2.3 + 0.75 / 9.(	357	5558	266	89.6%	64.7%	77.7%	310	12	0.6%	0	0.6%
15%	l.00 / 18.0 / 2.3 + 0.62 / 14.‹	353	5489	266	88.7%	63.9%	77.7%	304	12	0.6%	0	0.6%

* see text in Section 5 for explanation

Appendix D: IM240 Cutpoint Tables

IM240	Cutpoints	Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Composite + Mode 2	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
15%	1.00 / 15.0 / 2.3 + 0.62 / 12.0	353	5489	266	88.7%	63.9%	77.7%	304	12	0.6%	0	0.6%
15%	1.00 / 20.0 / 2.2 + 0.62 / 16.0	351	5431	273	88.2%	63.2%	79.7%	310	12	0.6%	0	0.6%
15%	1.20 / 20.0 / 2.1 + 0.75 / 16.0	349	5429	276	87.6%	63.2%	80.5%	316	12	0.6%	0	0.6%
15%	1.20 / 18.0 / 2.2 + 0.75 / 14.4	348	5434	269	87.4%	63.3%	78.7%	316	12	0.6%	0	0.6%
15%	1.20 / 15.0 / 2.2 + 0.75 / 12.0	348	5434	269	87.4%	63.3%	78.7%	316	12	0.6%	0	0.6%
15%	1.20 / 20.0 / 2.2 + 0.75 / 16.0	347	5375	269	87.0%	62.6%	78.7%	304	12	0.6%	0	0.6%
16%	0.80 / 20.0 / 2.2 + 0.50 / 16.0	365	5716	279	91.6%	66.6%	81.5%	340	12	0.6%	0	0.6%
16%	0.60 / 20.0 / 2.3 + 0.37 / 16.0	365	5718	272	91.6%	66.6%	79.5%	334	18	0.9%	0	0.9%
16%	0.80 / 20.0 / 2.3 + 0.50 / 16.0	365	5714	272	91.6%	66.5%	79.5%	322	12	0.6%	0	0.6%
16%	0.60 / 18.0 / 2.3 + 0.37 / 14.4	365	5723	272	91.6%	66.6%	79.5%	340	18	0.9%	0	0.9%
16%	0.80 / 18.0 / 2.3 + 0.50 / 14.4	365	5719	272	91.6%	66.6%	79.5%	328	12	0.6%	0	0.6%
16%	0.60 / 15.0 / 2.3 + 0.37 / 12.0	365	5723	272	91.6%	66.6%	79.5%	340	18	0.9%	0	0.9%
16%	0.80 / 15.0 / 2.3 + 0.50 / 12.0	365	5719	272	91.6%	66.6%	79.5%	328	12	0.6%	0	0.6%
16%	0.60 / 12.0 / 2.3 + 0.37 / 9.6	365	5723	272	91.6%	66.6%	79.5%	340	18	0.9%	0	0.9%
16%	0.80 / 12.0 / 2.3 + 0.50 / 9.6	365	5719	272	91.6%	66.6%	79.5%	328	12	0.6%	0	0.6%
16%	0.60 / 18.0 / 2.4 + 0.37 / 14.4	365	5713	268	91.6%	66.5%	78.3%	322	6	0.3%	0	0.3%
16%	0.60 / 15.0 / 2.4 + 0.37 / 12.0	365	5713	268	91.6%	66.5%	78.3%	322	6	0.3%	0	0.3%
16%	0.60 / 12.0 / 2.4 + 0.37 / 9.6	365	5713	268	91.6%	66.5%	78.3%	322	6	0.3%	0	0.3%
16%	1.00 / 12.0 / 2.1 + 0.62 / 9.6	359	5614	279	90.2%	65.4%	81.5%	340	12	0.6%	0	0.6%
16%	1.20 / 12.0 / 2.1 + 0.75 / 9.6	359	5614	279	90.2%	65.4%	81.5%	340	12	0.6%	0	0.6%
16%	1.00 / 12.0 / 2.2 + 0.62 / 9.6	357	5560	273	89.6%	64.7%	79.7%	328	12	0.6%	0	0.6%
16%	1.20 / 12.0 / 2.2 + 0.75 / 9.6	357	5560	273	89.6%	64.7%	79.7%	328	12	0.6%	0	0.6%
16%	1.00 / 10.0 / 2.4 + 0.62 / 8.0	357	5579	264	89.6%	65.0%	77.0%	340	42	2.0%	0	2.0%
16%	1.20 / 10.0 / 2.4 + 0.75 / 8.0	357	5579	264	89.6%	65.0%	77.0%	340	42	2.0%	0	2.0%
16%	1.00 / 10.0 / 2.5 + 0.62 / 8.0	356	5579	264	89.3%	65.0%	77.0%	334	42	2.0%	0	2.0%
16%	1.20 / 10.0 / 2.5 + 0.75 / 8.0	356	5579	264	89.3%	65.0%	77.0%	334	42	2.0%	0	2.0%
16%	1.00 / 18.0 / 2.0 + 0.62 / 14.4	356	5565	279	89.2%	64.8%	81.6%	340	12	0.6%	0	0.6%
16%	1.00 / 15.0 / 2.0 + 0.62 / 12.0	356	5565	279	89.2%	64.8%	81.6%	340	12	0.6%	0	0.6%
16%	1.00 / 18.0 / 2.1 + 0.62 / 14.4	356	5545	279	89.2%	64.6%	81.5%	334	12	0.6%	0	0.6%
16%	1.00 / 15.0 / 2.1 + 0.62 / 12.0	356	5545	279	89.2%	64.6%	81.5%	334	12	0.6%	0	0.6%
16%	1.00 / 20.0 / 1.9 + 0.62 / 16.0	354	5559	282	88.8%	64.7%	82.4%	340	12	0.6%	0	0.6%
16%	1.00 / 20.0 / 2.0 + 0.62 / 16.0	354	5505	279	88.8%	64.1%	81.6%	328	12	0.6%	0	0.6%
16%	1.00 / 20.0 / 2.1 + 0.62 / 16.0	354	5485	279	88.8%	63.9%	81.5%	322	12	0.6%	0	0.6%
16%	1.00 / 18.0 / 2.2 + 0.62 / 14.4	353	5491	273	88.7%	63.9%	79.7%	322	12	0.6%	0	0.6%
16%	1.00 / 15.0 / 2.2 + 0.62 / 12.0	353	5491	273	88.7%	63.9%	79.7%	322	12	0.6%	0	0.6%
16%	1.20 / 18.0 / 2.0 + 0.75 / 14.4	351	5508	276	88.0%	64.1%	80.6%	334	12	0.6%	0	0.6%

* see text in Section 5 for explanation

Appendix D: IM240 Cutpoint Tables

IM240	Cutpoints	Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Composite + Mode 2	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
16%	1.20 / 15.0 / 2.0 + 0.75 / 12.0	351	5508	276	88.0%	64.1%	80.6%	334	12	0.6%	0	0.6%
16%	1.20 / 18.0 / 2.1 + 0.75 / 14.4	351	5488	276	88.0%	63.9%	80.5%	328	12	0.6%	0	0.6%
16%	1.20 / 15.0 / 2.1 + 0.75 / 12.0	351	5488	276	88.0%	63.9%	80.5%	328	12	0.6%	0	0.6%
16%	1.20 / 20.0 / 1.9 + 0.75 / 16.0	349	5502	279	87.6%	64.1%	81.4%	334	12	0.6%	0	0.6%
16%	1.20 / 20.0 / 2.0 + 0.75 / 16.0	349	5449	276	87.6%	63.4%	80.6%	322	12	0.6%	0	0.6%
17%	0.80 / 20.0 / 2.0 + 0.50 / 16.0	367	5790	286	92.2%	67.4%	83.4%	358	12	0.6%	0	0.6%
17%	0.80 / 20.0 / 2.1 + 0.50 / 16.0	367	5770	285	92.2%	67.2%	83.3%	352	12	0.6%	0	0.6%
17%	0.80 / 18.0 / 2.1 + 0.50 / 14.4	367	5776	285	92.2%	67.2%	83.3%	358	12	0.6%	0	0.6%
17%	0.80 / 15.0 / 2.1 + 0.50 / 12.0	367	5776	285	92.2%	67.2%	83.3%	358	12	0.6%	0	0.6%
17%	0.80 / 12.0 / 2.1 + 0.50 / 9.6	367	5776	285	92.2%	67.2%	83.3%	358	12	0.6%	0	0.6%
17%	0.60 / 20.0 / 2.2 + 0.37 / 16.0	365	5720	279	91.6%	66.6%	81.5%	352	18	0.9%	0	0.9%
17%	0.60 / 18.0 / 2.2 + 0.37 / 14.4	365	5725	279	91.6%	66.7%	81.5%	358	18	0.9%	0	0.9%
17%	0.80 / 18.0 / 2.2 + 0.50 / 14.4	365	5721	279	91.6%	66.6%	81.5%	346	12	0.6%	0	0.6%
17%	0.60 / 15.0 / 2.2 + 0.37 / 12.0	365	5725	279	91.6%	66.7%	81.5%	358	18	0.9%	0	0.9%
17%	0.80 / 15.0 / 2.2 + 0.50 / 12.0	365	5721	279	91.6%	66.6%	81.5%	346	12	0.6%	0	0.6%
17%	0.60 / 12.0 / 2.2 + 0.37 / 9.6	365	5725	279	91.6%	66.7%	81.5%	358	18	0.9%	0	0.9%
17%	0.80 / 12.0 / 2.2 + 0.50 / 9.6	365	5721	279	91.6%	66.6%	81.5%	346	12	0.6%	0	0.6%
17%	0.80 / 10.0 / 2.4 + 0.50 / 8.0	365	5740	270	91.6%	66.8%	78.8%	358	42	2.0%	0	2.0%
17%	0.80 / 10.0 / 2.5 + 0.50 / 8.0	364	5740	270	91.3%	66.8%	78.8%	352	42	2.0%	0	2.0%
17%	1.00 / 12.0 / 1.9 + 0.62 / 9.6	359	5688	282	90.2%	66.2%	82.4%	358	12	0.6%	0	0.6%
17%	1.20 / 12.0 / 1.9 + 0.75 / 9.6	359	5688	282	90.2%	66.2%	82.4%	358	12	0.6%	0	0.6%
17%	1.00 / 12.0 / 2.0 + 0.62 / 9.6	359	5634	279	90.2%	65.6%	81.6%	346	12	0.6%	0	0.6%
17%	1.20 / 12.0 / 2.0 + 0.75 / 9.6	359	5634	279	90.2%	65.6%	81.6%	346	12	0.6%	0	0.6%
17%	1.00 / 10.0 / 2.3 + 0.62 / 8.0	357	5589	268	89.6%	65.1%	78.2%	358	54	2.6%	0	2.6%
17%	1.20 / 10.0 / 2.3 + 0.75 / 8.0	357	5589	268	89.6%	65.1%	78.2%	358	54	2.6%	0	2.6%
17%	1.00 / 18.0 / 1.9 + 0.62 / 14.4	356	5618	282	89.3%	65.4%	82.4%	352	12	0.6%	0	0.6%
17%	1.00 / 15.0 / 1.9 + 0.62 / 12.0	356	5618	282	89.3%	65.4%	82.4%	352	12	0.6%	0	0.6%
17%	1.20 / 18.0 / 1.9 + 0.75 / 14.4	351	5562	279	88.0%	64.8%	81.4%	346	12	0.6%	0	0.6%
17%	1.20 / 15.0 / 1.9 + 0.75 / 12.0	351	5562	279	88.0%	64.8%	81.4%	346	12	0.6%	0	0.6%
18%	0.40 / 20.0 / 2.4 + 0.25 / 16.0	371	5923	276	93.0%	69.0%	80.7%	382	6	0.3%	0	0.3%
18%	0.40 / 18.0 / 2.4 + 0.25 / 14.4	371	5923	276	93.0%	69.0%	80.7%	382	6	0.3%	0	0.3%
18%	0.40 / 15.0 / 2.4 + 0.25 / 12.0	371	5923	276	93.0%	69.0%	80.7%	382	6	0.3%	0	0.3%
18%	0.40 / 12.0 / 2.4 + 0.25 / 9.6	371	5923	276	93.0%	69.0%	80.7%	382	6	0.3%	0	0.3%
18%	0.40 / 20.0 / 2.5 + 0.25 / 16.0	370	5923	276	92.8%	69.0%	80.7%	376	6	0.3%	0	0.3%
18%	0.40 / 18.0 / 2.5 + 0.25 / 14.4	370	5923	276	92.8%	69.0%	80.7%	376	6	0.3%	0	0.3%
18%	0.40 / 15.0 / 2.5 + 0.25 / 12.0	370	5923	276	92.8%	69.0%	80.7%	376	6	0.3%	0	0.3%

* see text in Section 5 for explanation

Appendix D: IM240 Cutpoint Tables

IM240	Cutpoints	Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Composite + Mode 2	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
18%	).40 / 12.0 / 2.5 + 0.25 / 9.(	370	5923	276	92.8%	69.0%	80.7%	376	6	0.3%	0	0.3%
18%	).60 / 20.0 / 1.9 + 0.37 / 16.(	367	5847	288	92.2%	68.1%	84.2%	382	18	0.9%	0	0.9%
18%	).80 / 20.0 / 1.9 + 0.50 / 16.(	367	5844	288	92.2%	68.0%	84.2%	370	12	0.6%	0	0.6%
18%	).80 / 18.0 / 1.9 + 0.50 / 14.4	367	5849	288	92.2%	68.1%	84.2%	376	12	0.6%	0	0.6%
18%	).80 / 15.0 / 1.9 + 0.50 / 12.(	367	5849	288	92.2%	68.1%	84.2%	376	12	0.6%	0	0.6%
18%	).80 / 12.0 / 1.9 + 0.50 / 9.(	367	5849	288	92.2%	68.1%	84.2%	376	12	0.6%	0	0.6%
18%	.50 / 12.0 / 2.0 + 0.31 / 10.0	367	5799	286	92.2%	67.5%	83.4%	376	18	0.9%	0	0.9%
18%	.60 / 12.0 / 2.0 + 0.38 / 10.0	367	5799	286	92.2%	67.5%	83.4%	376	18	0.9%	0	0.9%
18%	).60 / 20.0 / 2.0 + 0.37 / 16.(	367	5794	286	92.2%	67.5%	83.4%	370	18	0.9%	0	0.9%
18%	).60 / 18.0 / 2.0 + 0.37 / 14.4	367	5799	286	92.2%	67.5%	83.4%	376	18	0.9%	0	0.9%
18%	).80 / 18.0 / 2.0 + 0.50 / 14.4	367	5796	286	92.2%	67.5%	83.4%	364	12	0.6%	0	0.6%
18%	).60 / 15.0 / 2.0 + 0.37 / 12.(	367	5799	286	92.2%	67.5%	83.4%	376	18	0.9%	0	0.9%
18%	**).80 / 15.0 / 2.0 + 0.50 / 12.(**	**367**	**5796**	**286**	**92.2%**	**67.5%**	**83.4%**	**364**	**12**	**0.6%**	**0**	**0.6%**
18%	).60 / 12.0 / 2.0 + 0.37 / 9.(	367	5799	286	92.2%	67.5%	83.4%	376	18	0.9%	0	0.9%
18%	).80 / 12.0 / 2.0 + 0.50 / 9.(	367	5796	286	92.2%	67.5%	83.4%	364	12	0.6%	0	0.6%
18%	.50 / 12.0 / 2.1 + 0.31 / 10.0	367	5779	285	92.2%	67.3%	83.3%	370	18	0.9%	0	0.9%
18%	.60 / 12.0 / 2.1 + 0.38 / 10.0	367	5779	285	92.2%	67.3%	83.3%	370	18	0.9%	0	0.9%
18%	).60 / 20.0 / 2.1 + 0.37 / 16.(	367	5774	285	92.2%	67.2%	83.3%	364	18	0.9%	0	0.9%
18%	).60 / 18.0 / 2.1 + 0.37 / 14.4	367	5779	285	92.2%	67.3%	83.3%	370	18	0.9%	0	0.9%
18%	).60 / 15.0 / 2.1 + 0.37 / 12.(	367	5779	285	92.2%	67.3%	83.3%	370	18	0.9%	0	0.9%
18%	).60 / 12.0 / 2.1 + 0.37 / 9.(	367	5779	285	92.2%	67.3%	83.3%	370	18	0.9%	0	0.9%
18%	).80 / 10.0 / 2.3 + 0.50 / 8.(	365	5750	274	91.6%	66.9%	80.0%	376	54	2.6%	0	2.6%
18%	).60 / 10.0 / 2.4 + 0.37 / 8.(	365	5744	270	91.6%	66.9%	78.8%	370	48	2.3%	0	2.3%
18%	).60 / 10.0 / 2.5 + 0.37 / 8.(	364	5744	270	91.3%	66.9%	78.8%	364	48	2.3%	0	2.3%
18%	l.00 / 10.0 / 2.2 + 0.62 / 8.(	357	5591	274	89.6%	65.1%	80.2%	376	54	2.6%	0	2.6%
18%	l.20 / 10.0 / 2.2 + 0.75 / 8.(	357	5591	274	89.6%	65.1%	80.2%	376	54	2.6%	0	2.6%
19%	).40 / 20.0 / 2.3 + 0.25 / 16.(	371	5933	281	93.0%	69.1%	81.9%	400	18	0.9%	0	0.9%
19%	).40 / 18.0 / 2.3 + 0.25 / 14.4	371	5933	281	93.0%	69.1%	81.9%	400	18	0.9%	0	0.9%
19%	).40 / 15.0 / 2.3 + 0.25 / 12.(	371	5933	281	93.0%	69.1%	81.9%	400	18	0.9%	0	0.9%
19%	).40 / 12.0 / 2.3 + 0.25 / 9.(	371	5933	281	93.0%	69.1%	81.9%	400	18	0.9%	0	0.9%
19%	.50 / 12.0 / 1.9 + 0.31 / 10.0	367	5853	288	92.2%	68.1%	84.2%	388	18	0.9%	0	0.9%
19%	.60 / 12.0 / 1.9 + 0.38 / 10.0	367	5853	288	92.2%	68.1%	84.2%	388	18	0.9%	0	0.9%
19%	.50 / 12.0 / 1.8 + 0.31 / 10.0	367	5853	288	92.2%	68.1%	84.2%	388	18	0.9%	0	0.9%
19%	.60 / 12.0 / 1.8 + 0.38 / 10.0	367	5853	288	92.2%	68.1%	84.2%	388	18	0.9%	0	0.9%
19%	).60 / 18.0 / 1.9 + 0.37 / 14.4	367	5853	288	92.2%	68.1%	84.2%	388	18	0.9%	0	0.9%
19%	).60 / 15.0 / 1.9 + 0.37 / 12.(	367	5853	288	92.2%	68.1%	84.2%	388	18	0.9%	0	0.9%

* see text in Section 5 for explanation

Appendix D: IM240 Cutpoint Tables

IM240	Cutpoints	Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Composite + Mode 2	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
19%	).60 / 12.0 / 1.9 + 0.37 / 9.(	367	5853	288	92.2%	68.1%	84.2%	388	18	0.9%	0	0.9%
19%	).80 / 10.0 / 2.2 + 0.50 / 8.(	365	5752	281	91.6%	67.0%	82.0%	394	54	2.6%	0	2.6%
19%	).60 / 10.0 / 2.3 + 0.37 / 8.(	365	5754	274	91.6%	67.0%	80.0%	388	60	2.9%	0	2.9%
19%	l.00 / 10.0 / 1.9 + 0.62 / 8.(	359	5688	282	90.2%	66.2%	82.4%	400	54	2.6%	0	2.6%
19%	l.20 / 10.0 / 1.9 + 0.75 / 8.(	359	5688	282	90.2%	66.2%	82.4%	400	54	2.6%	0	2.6%
19%	l.00 / 10.0 / 2.0 + 0.62 / 8.(	359	5665	281	90.2%	66.0%	82.1%	394	54	2.6%	0	2.6%
19%	l.20 / 10.0 / 2.0 + 0.75 / 8.(	359	5665	281	90.2%	66.0%	82.1%	394	54	2.6%	0	2.6%
19%	l.00 / 10.0 / 2.1 + 0.62 / 8.(	359	5645	281	90.2%	65.7%	82.0%	388	54	2.6%	0	2.6%
19%	l.20 / 10.0 / 2.1 + 0.75 / 8.(	359	5645	281	90.2%	65.7%	82.0%	388	54	2.6%	0	2.6%
20%	.40 / 12.0 / 2.1 + 0.25 / 10.0	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	.40 / 12.0 / 2.0 + 0.25 / 10.0	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	).40 / 20.0 / 2.2 + 0.25 / 16.(	371	5935	287	93.0%	69.1%	83.9%	418	18	0.9%	0	0.9%
20%	).40 / 18.0 / 2.2 + 0.25 / 14.4	371	5935	287	93.0%	69.1%	83.9%	418	18	0.9%	0	0.9%
20%	).40 / 15.0 / 2.2 + 0.25 / 12.(	371	5935	287	93.0%	69.1%	83.9%	418	18	0.9%	0	0.9%
20%	).40 / 12.0 / 2.2 + 0.25 / 9.(	371	5935	287	93.0%	69.1%	83.9%	418	18	0.9%	0	0.9%
20%	).40 / 20.0 / 2.1 + 0.25 / 16.(	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	).40 / 18.0 / 2.1 + 0.25 / 14.4	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	).40 / 15.0 / 2.1 + 0.25 / 12.(	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	).40 / 12.0 / 2.1 + 0.25 / 9.(	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	).40 / 20.0 / 2.0 + 0.25 / 16.(	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	).40 / 18.0 / 2.0 + 0.25 / 14.4	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	).40 / 15.0 / 2.0 + 0.25 / 12.(	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	).40 / 12.0 / 2.0 + 0.25 / 9.(	371	5952	287	93.0%	69.3%	83.9%	424	18	0.9%	0	0.9%
20%	).40 / 10.0 / 2.4 + 0.25 / 8.(	371	5923	276	93.0%	69.0%	80.7%	424	48	2.3%	0	2.3%
20%	).40 / 10.0 / 2.5 + 0.25 / 8.(	370	5923	276	92.8%	69.0%	80.7%	418	48	2.3%	0	2.3%
20%	).80 / 10.0 / 1.9 + 0.50 / 8.(	367	5849	288	92.2%	68.1%	84.2%	418	54	2.6%	0	2.6%
20%	.50 / 11.0 / 2.0 + 0.31 / 9.0	367	5830	287	92.2%	67.9%	83.9%	424	60	2.9%	0	2.9%
20%	.60 / 11.0 / 2.0 + 0.38 / 9.0	367	5830	287	92.2%	67.9%	83.9%	424	60	2.9%	0	2.9%
20%	.50 / 10.0 / 2.0 + 0.31 / 8.0	367	5830	287	92.2%	67.9%	83.9%	424	60	2.9%	0	2.9%
20%	.60 / 10.0 / 2.0 + 0.38 / 8.0	367	5830	287	92.2%	67.9%	83.9%	424	60	2.9%	0	2.9%
20%	).60 / 10.0 / 2.0 + 0.37 / 8.(	367	5830	287	92.2%	67.9%	83.9%	424	60	2.9%	0	2.9%
20%	).80 / 10.0 / 2.0 + 0.50 / 8.(	367	5826	287	92.2%	67.8%	83.9%	412	54	2.6%	0	2.6%
20%	.50 / 11.0 / 2.1 + 0.31 / 9.0	367	5810	287	92.2%	67.6%	83.8%	418	60	2.9%	0	2.9%
20%	.60 / 11.0 / 2.1 + 0.38 / 9.0	367	5810	287	92.2%	67.6%	83.8%	418	60	2.9%	0	2.9%
20%	.50 / 10.0 / 2.1 + 0.31 / 8.0	367	5810	287	92.2%	67.6%	83.8%	418	60	2.9%	0	2.9%
20%	.60 / 10.0 / 2.1 + 0.38 / 8.0	367	5810	287	92.2%	67.6%	83.8%	418	60	2.9%	0	2.9%

* see text in Section 5 for explanation

Appendix D: IM240 Cutpoint Tables

IM240 Failure Rate	Cutpoints Composite + Mode 2	Excess Emissions Identified HC	CO	NOx	Identification Rates HC	CO	NOx	Fails	Errors of Commission	Ec Rate*	Discrepant Failures	Probable Ec Rate
20%	).60 / 10.0 / 2.1 + 0.37 / 8.(	367	5810	287	92.2%	67.6%	83.8%	418	60	2.9%	0	2.9%
20%	).80 / 10.0 / 2.1 + 0.50 / 8.(	367	5807	287	92.2%	67.6%	83.8%	406	54	2.6%	0	2.6%
20%	).60 / 10.0 / 2.2 + 0.37 / 8.(	365	5756	281	91.6%	67.0%	82.0%	406	60	2.9%	0	2.9%
21%	.40 / 12.0 / 1.9 + 0.25 / 10.0	371	5975	288	93.1%	69.6%	84.2%	430	18	0.9%	0	0.9%
21%	.40 / 12.0 / 1.8 + 0.25 / 10.0	371	5975	288	93.1%	69.6%	84.2%	430	18	0.9%	0	0.9%
21%	).40 / 20.0 / 1.9 + 0.25 / 16.(	371	5975	288	93.1%	69.6%	84.2%	430	18	0.9%	0	0.9%
21%	).40 / 18.0 / 1.9 + 0.25 / 14.4	371	5975	288	93.1%	69.6%	84.2%	430	18	0.9%	0	0.9%
21%	).40 / 15.0 / 1.9 + 0.25 / 12.(	371	5975	288	93.1%	69.6%	84.2%	430	18	0.9%	0	0.9%
21%	).40 / 12.0 / 1.9 + 0.25 / 9.6	371	5975	288	93.1%	69.6%	84.2%	430	18	0.9%	0	0.9%
21%	).40 / 10.0 / 2.3 + 0.25 / 8.(	371	5933	281	93.0%	69.1%	81.9%	442	60	2.9%	0	2.9%
21%	.50 / 12.0 / 1.7 + 0.31 / 10.0	368	6029	299	92.3%	70.2%	87.3%	430	18	0.9%	0	0.9%
21%	.60 / 12.0 / 1.7 + 0.38 / 10.0	368	6029	299	92.3%	70.2%	87.3%	430	18	0.9%	0	0.9%
21%	.50 / 12.0 / 1.6 + 0.31 / 10.0	368	6029	299	92.3%	70.2%	87.3%	430	18	0.9%	0	0.9%
21%	.60 / 12.0 / 1.6 + 0.38 / 10.0	368	6029	299	92.3%	70.2%	87.3%	430	18	0.9%	0	0.9%
21%	.50 / 11.0 / 1.9 + 0.31 / 9.0	367	5853	288	92.2%	68.1%	84.2%	430	60	2.9%	0	2.9%
21%	.60 / 11.0 / 1.9 + 0.38 / 9.0	367	5853	288	92.2%	68.1%	84.2%	430	60	2.9%	0	2.9%
21%	.50 / 10.0 / 1.9 + 0.31 / 8.0	367	5853	288	92.2%	68.1%	84.2%	430	60	2.9%	0	2.9%
21%	.60 / 10.0 / 1.9 + 0.38 / 8.0	367	5853	288	92.2%	68.1%	84.2%	430	60	2.9%	0	2.9%
21%	.50 / 11.0 / 1.8 + 0.31 / 9.0	367	5853	288	92.2%	68.1%	84.2%	430	60	2.9%	0	2.9%
21%	.60 / 11.0 / 1.8 + 0.38 / 9.0	367	5853	288	92.2%	68.1%	84.2%	430	60	2.9%	0	2.9%
21%	.50 / 10.0 / 1.8 + 0.31 / 8.0	367	5853	288	92.2%	68.1%	84.2%	430	60	2.9%	0	2.9%
21%	.60 / 10.0 / 1.8 + 0.38 / 8.0	367	5853	288	92.2%	68.1%	84.2%	430	60	2.9%	0	2.9%
21%	).60 / 10.0 / 1.9 + 0.37 / 8.(	367	5853	288	92.2%	68.1%	84.2%	430	60	2.9%	0	2.9%
22%	.50 / 9.0 / 2.1 + 0.31 / 7.0	372	6124	309	93.5%	71.3%	90.3%	460	60	2.9%	0	2.9%
22%	.60 / 9.0 / 2.1 + 0.38 / 7.0	372	6124	309	93.5%	71.3%	90.3%	460	60	2.9%	0	2.9%
22%	).40 / 10.0 / 2.2 + 0.25 / 8.(	371	5935	287	93.0%	69.1%	83.9%	460	60	2.9%	0	2.9%
23%	.50 / 9.0 / 1.9 + 0.31 / 7.0	372	6167	310	93.5%	71.8%	90.7%	472	60	2.9%	0	2.9%
23%	.60 / 9.0 / 1.9 + 0.38 / 7.0	372	6167	310	93.5%	71.8%	90.7%	472	60	2.9%	0	2.9%
23%	.50 / 9.0 / 1.8 + 0.31 / 7.0	372	6167	310	93.5%	71.8%	90.7%	472	60	2.9%	0	2.9%
23%	.60 / 9.0 / 1.8 + 0.38 / 7.0	372	6167	310	93.5%	71.8%	90.7%	472	60	2.9%	0	2.9%
23%	.50 / 9.0 / 2.0 + 0.31 / 7.0	372	6144	310	93.5%	71.5%	90.4%	466	60	2.9%	0	2.9%
23%	.60 / 9.0 / 2.0 + 0.38 / 7.0	372	6144	310	93.5%	71.5%	90.4%	466	60	2.9%	0	2.9%
23%	.40 / 12.0 / 1.7 + 0.25 / 10.0	371	6151	299	93.2%	71.6%	87.3%	472	18	0.9%	0	0.9%
23%	.40 / 12.0 / 1.6 + 0.25 / 10.0	371	6151	299	93.2%	71.6%	87.3%	472	18	0.9%	0	0.9%
23%	.40 / 11.0 / 1.9 + 0.25 / 9.0	371	5975	288	93.1%	69.6%	84.2%	472	60	2.9%	0	2.9%
23%	.40 / 10.0 / 1.9 + 0.25 / 8.0	371	5975	288	93.1%	69.6%	84.2%	472	60	2.9%	0	2.9%

* see text in Section 5 for explanation

Appendix D: IM240 Cutpoint Tables

IM240	Cutpoints	Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Composite + Mode 2	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
23%	.40 / 11.0 / 1.8 + 0.25 / 9.0	371	5975	288	93.1%	69.6%	84.2%	472	60	2.9%	0	2.9%
23%	.40 / 10.0 / 1.8 + 0.25 / 8.0	371	5975	288	93.1%	69.6%	84.2%	472	60	2.9%	0	2.9%
23%	).40 / 10.0 / 1.9 + 0.25 / 8.(	371	5975	288	93.1%	69.6%	84.2%	472	60	2.9%	0	2.9%
23%	.40 / 11.0 / 2.1 + 0.25 / 9.0	371	5952	287	93.0%	69.3%	83.9%	466	60	2.9%	0	2.9%
23%	.40 / 10.0 / 2.1 + 0.25 / 8.0	371	5952	287	93.0%	69.3%	83.9%	466	60	2.9%	0	2.9%
23%	.40 / 11.0 / 2.0 + 0.25 / 9.0	371	5952	287	93.0%	69.3%	83.9%	466	60	2.9%	0	2.9%
23%	.40 / 10.0 / 2.0 + 0.25 / 8.0	371	5952	287	93.0%	69.3%	83.9%	466	60	2.9%	0	2.9%
23%	).40 / 10.0 / 2.1 + 0.25 / 8.(	371	5952	287	93.0%	69.3%	83.9%	466	60	2.9%	0	2.9%
23%	).40 / 10.0 / 2.0 + 0.25 / 8.(	371	5952	287	93.0%	69.3%	83.9%	466	60	2.9%	0	2.9%
23%	.50 / 11.0 / 1.7 + 0.31 / 9.0	368	6029	299	92.3%	70.2%	87.3%	472	60	2.9%	0	2.9%
23%	.60 / 11.0 / 1.7 + 0.38 / 9.0	368	6029	299	92.3%	70.2%	87.3%	472	60	2.9%	0	2.9%
23%	.50 / 10.0 / 1.7 + 0.31 / 8.0	368	6029	299	92.3%	70.2%	87.3%	472	60	2.9%	0	2.9%
23%	.60 / 10.0 / 1.7 + 0.38 / 8.0	368	6029	299	92.3%	70.2%	87.3%	472	60	2.9%	0	2.9%
23%	.50 / 11.0 / 1.6 + 0.31 / 9.0	368	6029	299	92.3%	70.2%	87.3%	472	60	2.9%	0	2.9%
23%	.60 / 11.0 / 1.6 + 0.38 / 9.0	368	6029	299	92.3%	70.2%	87.3%	472	60	2.9%	0	2.9%
23%	.50 / 10.0 / 1.6 + 0.31 / 8.0	368	6029	299	92.3%	70.2%	87.3%	472	60	2.9%	0	2.9%
23%	.60 / 10.0 / 1.6 + 0.38 / 8.0	368	6029	299	92.3%	70.2%	87.3%	472	60	2.9%	0	2.9%
23%	.50 / 12.0 / 1.5 + 0.31 / 10.0	368	6041	299	92.3%	70.3%	87.3%	472	18	0.9%	48	3.2%
23%	.60 / 12.0 / 1.5 + 0.38 / 10.0	368	6041	299	92.3%	70.3%	87.3%	472	18	0.9%	48	3.2%
24%	.50 / 8.0 / 2.1 + 0.31 / 6.0	376	6246	309	94.3%	72.7%	90.3%	502	60	2.9%	0	2.9%
24%	.60 / 8.0 / 2.1 + 0.38 / 6.0	376	6246	309	94.3%	72.7%	90.3%	502	60	2.9%	0	2.9%
25%	.40 / 9.0 / 1.9 + 0.25 / 7.0	376	6289	310	94.3%	73.2%	90.7%	514	60	2.9%	0	2.9%
25%	.40 / 8.0 / 1.9 + 0.25 / 6.0	376	6289	310	94.3%	73.2%	90.7%	514	60	2.9%	0	2.9%
25%	.50 / 8.0 / 1.9 + 0.31 / 6.0	376	6289	310	94.3%	73.2%	90.7%	514	60	2.9%	0	2.9%
25%	.60 / 8.0 / 1.9 + 0.38 / 6.0	376	6289	310	94.3%	73.2%	90.7%	514	60	2.9%	0	2.9%
25%	.40 / 9.0 / 1.8 + 0.25 / 7.0	376	6289	310	94.3%	73.2%	90.7%	514	60	2.9%	0	2.9%
25%	.40 / 8.0 / 1.8 + 0.25 / 6.0	376	6289	310	94.3%	73.2%	90.7%	514	60	2.9%	0	2.9%
25%	.50 / 8.0 / 1.8 + 0.31 / 6.0	376	6289	310	94.3%	73.2%	90.7%	514	60	2.9%	0	2.9%
25%	.60 / 8.0 / 1.8 + 0.38 / 6.0	376	6289	310	94.3%	73.2%	90.7%	514	60	2.9%	0	2.9%
25%	.40 / 9.0 / 2.1 + 0.25 / 7.0	376	6266	310	94.3%	73.0%	90.4%	508	60	2.9%	0	2.9%
25%	.40 / 8.0 / 2.1 + 0.25 / 6.0	376	6266	310	94.3%	73.0%	90.4%	508	60	2.9%	0	2.9%
25%	.40 / 9.0 / 2.0 + 0.25 / 7.0	376	6266	310	94.3%	73.0%	90.4%	508	60	2.9%	0	2.9%
25%	.40 / 8.0 / 2.0 + 0.25 / 6.0	376	6266	310	94.3%	73.0%	90.4%	508	60	2.9%	0	2.9%
25%	.50 / 8.0 / 2.0 + 0.31 / 6.0	376	6266	310	94.3%	73.0%	90.4%	508	60	2.9%	0	2.9%
25%	.60 / 8.0 / 2.0 + 0.38 / 6.0	376	6266	310	94.3%	73.0%	90.4%	508	60	2.9%	0	2.9%
25%	.50 / 9.0 / 1.7 + 0.31 / 7.0	373	6343	321	93.6%	73.9%	93.8%	514	60	2.9%	0	2.9%

* see text in Section 5 for explanation

IM240	Cutpoints	Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Composite + Mode 2	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
25%	.60 / 9.0 / 1.7 + 0.38 / 7.0	373	6343	321	93.6%	73.9%	93.8%	514	60	2.9%	0	2.9%
25%	.50 / 9.0 / 1.6 + 0.31 / 7.0	373	6343	321	93.6%	73.9%	93.8%	514	60	2.9%	0	2.9%
25%	.60 / 9.0 / 1.6 + 0.38 / 7.0	373	6343	321	93.6%	73.9%	93.8%	514	60	2.9%	0	2.9%
25%	.40 / 11.0 / 1.7 + 0.25 / 9.0	371	6151	299	93.2%	71.6%	87.3%	514	60	2.9%	0	2.9%
25%	.40 / 10.0 / 1.7 + 0.25 / 8.0	371	6151	299	93.2%	71.6%	87.3%	514	60	2.9%	0	2.9%
25%	.40 / 11.0 / 1.6 + 0.25 / 9.0	371	6151	299	93.2%	71.6%	87.3%	514	60	2.9%	0	2.9%
25%	.40 / 10.0 / 1.6 + 0.25 / 8.0	371	6151	299	93.2%	71.6%	87.3%	514	60	2.9%	0	2.9%
25%	.40 / 12.0 / 1.5 + 0.25 / 10.0	371	6163	299	93.2%	71.8%	87.3%	514	18	0.9%	48	3.2%
25%	.50 / 11.0 / 1.5 + 0.31 / 9.0	368	6041	299	92.3%	70.3%	87.3%	514	60	2.9%	48	5.2%
25%	.60 / 11.0 / 1.5 + 0.38 / 9.0	368	6041	299	92.3%	70.3%	87.3%	514	60	2.9%	48	5.2%
25%	.50 / 10.0 / 1.5 + 0.31 / 8.0	368	6041	299	92.3%	70.3%	87.3%	514	60	2.9%	42	4.9%
25%	.60 / 10.0 / 1.5 + 0.38 / 8.0	368	6041	299	92.3%	70.3%	87.3%	514	60	2.9%	42	4.9%
27%	.40 / 9.0 / 1.7 + 0.25 / 7.0	376	6465	321	94.4%	75.3%	93.8%	556	60	2.9%	0	2.9%
27%	.40 / 8.0 / 1.7 + 0.25 / 6.0	376	6465	321	94.4%	75.3%	93.8%	556	60	2.9%	0	2.9%
27%	.50 / 8.0 / 1.7 + 0.31 / 6.0	376	6465	321	94.4%	75.3%	93.8%	556	60	2.9%	0	2.9%
27%	.60 / 8.0 / 1.7 + 0.38 / 6.0	376	6465	321	94.4%	75.3%	93.8%	556	60	2.9%	0	2.9%
27%	.40 / 9.0 / 1.6 + 0.25 / 7.0	376	6465	321	94.4%	75.3%	93.8%	556	60	2.9%	0	2.9%
27%	.40 / 8.0 / 1.6 + 0.25 / 6.0	376	6465	321	94.4%	75.3%	93.8%	556	60	2.9%	0	2.9%
27%	.50 / 8.0 / 1.6 + 0.31 / 6.0	376	6465	321	94.4%	75.3%	93.8%	556	60	2.9%	0	2.9%
27%	.60 / 8.0 / 1.6 + 0.38 / 6.0	376	6465	321	94.4%	75.3%	93.8%	556	60	2.9%	0	2.9%
27%	.50 / 9.0 / 1.5 + 0.31 / 7.0	373	6355	321	93.6%	74.0%	93.8%	556	60	2.9%	42	4.9%
27%	.60 / 9.0 / 1.5 + 0.38 / 7.0	373	6355	321	93.6%	74.0%	93.8%	556	60	2.9%	42	4.9%
27%	.40 / 11.0 / 1.5 + 0.25 / 9.0	371	6163	299	93.2%	71.8%	87.3%	556	60	2.9%	48	5.2%
27%	.40 / 10.0 / 1.5 + 0.25 / 8.0	371	6163	299	93.2%	71.8%	87.3%	556	60	2.9%	42	4.9%
29%	.30 / 12.0 / 2.1 + 0.19 / 10.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 11.0 / 2.1 + 0.19 / 9.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 10.0 / 2.1 + 0.19 / 8.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 12.0 / 2.0 + 0.19 / 10.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 11.0 / 2.0 + 0.19 / 9.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 10.0 / 2.0 + 0.19 / 8.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 12.0 / 1.9 + 0.19 / 10.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 11.0 / 1.9 + 0.19 / 9.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 10.0 / 1.9 + 0.19 / 8.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 12.0 / 1.8 + 0.19 / 10.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 11.0 / 1.8 + 0.19 / 9.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%
29%	.30 / 10.0 / 1.8 + 0.19 / 8.0	377	6228	300	94.5%	72.5%	87.5%	598	60	2.9%	0	2.9%

* see text in Section 5 for explanation

Appendix D: IM240 Cutpoint Tables

IM240	Cutpoints	Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Composite + Mode 2	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
29%	.40 / 9.0 / 1.5 + 0.25 / 7.0	376	6477	321	94.4%	75.4%	93.8%	598	60	2.9%	42	4.9%
29%	.40 / 8.0 / 1.5 + 0.25 / 6.0	376	6477	321	94.4%	75.4%	93.8%	598	60	2.9%	42	4.9%
29%	.50 / 8.0 / 1.5 + 0.31 / 6.0	376	6477	321	94.4%	75.4%	93.8%	598	60	2.9%	42	4.9%
29%	.60 / 8.0 / 1.5 + 0.38 / 6.0	376	6477	321	94.4%	75.4%	93.8%	598	60	2.9%	42	4.9%
31%	.30 / 9.0 / 2.1 + 0.19 / 7.0	382	6543	322	95.8%	76.2%	94.0%	639	60	2.9%	0	2.9%
31%	.30 / 8.0 / 2.1 + 0.19 / 6.0	382	6543	322	95.8%	76.2%	94.0%	639	60	2.9%	0	2.9%
31%	.30 / 9.0 / 2.0 + 0.19 / 7.0	382	6543	322	95.8%	76.2%	94.0%	639	60	2.9%	0	2.9%
31%	.30 / 8.0 / 2.0 + 0.19 / 6.0	382	6543	322	95.8%	76.2%	94.0%	639	60	2.9%	0	2.9%
31%	.30 / 9.0 / 1.9 + 0.19 / 7.0	382	6543	322	95.8%	76.2%	94.0%	639	60	2.9%	0	2.9%
31%	.30 / 8.0 / 1.9 + 0.19 / 6.0	382	6543	322	95.8%	76.2%	94.0%	639	60	2.9%	0	2.9%
31%	.30 / 9.0 / 1.8 + 0.19 / 7.0	382	6543	322	95.8%	76.2%	94.0%	639	60	2.9%	0	2.9%
31%	.30 / 8.0 / 1.8 + 0.19 / 6.0	382	6543	322	95.8%	76.2%	94.0%	639	60	2.9%	0	2.9%
31%	.30 / 12.0 / 1.7 + 0.19 / 10.0	377	6405	310	94.6%	74.6%	90.6%	639	60	2.9%	0	2.9%
31%	.30 / 11.0 / 1.7 + 0.19 / 9.0	377	6405	310	94.6%	74.6%	90.6%	639	60	2.9%	0	2.9%
31%	.30 / 10.0 / 1.7 + 0.19 / 8.0	377	6405	310	94.6%	74.6%	90.6%	639	60	2.9%	0	2.9%
31%	.30 / 12.0 / 1.6 + 0.19 / 10.0	377	6405	310	94.6%	74.6%	90.6%	639	60	2.9%	0	2.9%
31%	.30 / 11.0 / 1.6 + 0.19 / 9.0	377	6405	310	94.6%	74.6%	90.6%	639	60	2.9%	0	2.9%
31%	.30 / 10.0 / 1.6 + 0.19 / 8.0	377	6405	310	94.6%	74.6%	90.6%	639	60	2.9%	0	2.9%
33%	.30 / 9.0 / 1.7 + 0.19 / 7.0	382	6719	332	95.9%	78.2%	97.1%	681	60	2.9%	0	2.9%
33%	.30 / 8.0 / 1.7 + 0.19 / 6.0	382	6719	332	95.9%	78.2%	97.1%	681	60	2.9%	0	2.9%
33%	.30 / 9.0 / 1.6 + 0.19 / 7.0	382	6719	332	95.9%	78.2%	97.1%	681	60	2.9%	0	2.9%
33%	.30 / 8.0 / 1.6 + 0.19 / 6.0	382	6719	332	95.9%	78.2%	97.1%	681	60	2.9%	0	2.9%
33%	.30 / 12.0 / 1.5 + 0.19 / 10.0	377	6417	310	94.6%	74.7%	90.6%	681	60	2.9%	48	5.2%
33%	.30 / 11.0 / 1.5 + 0.19 / 9.0	377	6417	310	94.6%	74.7%	90.6%	681	60	2.9%	48	5.2%
33%	.30 / 10.0 / 1.5 + 0.19 / 8.0	377	6417	310	94.6%	74.7%	90.6%	681	60	2.9%	42	4.9%
35%	.30 / 9.0 / 1.5 + 0.19 / 7.0	382	6731	332	95.9%	78.4%	97.1%	723	60	2.9%	42	4.9%
35%	.30 / 8.0 / 1.5 + 0.19 / 6.0	382	6731	332	95.9%	78.4%	97.1%	723	60	2.9%	42	4.9%
47%	.20 / 12.0 / 2.1 + 0.13 / 10.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 11.0 / 2.1 + 0.13 / 9.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 10.0 / 2.1 + 0.13 / 8.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 9.0 / 2.1 + 0.13 / 7.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 8.0 / 2.1 + 0.13 / 6.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 12.0 / 2.0 + 0.13 / 10.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 11.0 / 2.0 + 0.13 / 9.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 10.0 / 2.0 + 0.13 / 8.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 9.0 / 2.0 + 0.13 / 7.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%

* see text in Section 5 for explanation

Appendix D: IM240 Cutpoint Tables

IM240 Failure Rate	Cutpoints Composite + Mode 2	Excess Emissions Identified HC	CO	NOx	Identification Rates HC	CO	NOx	Fails	Errors of Commission	Ec Rate*	Discrepant Failures	Probable Ec Rate
47%	.20 / 8.0 / 2.0 + 0.13 / 6.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 12.0 / 1.9 + 0.13 / 10.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 11.0 / 1.9 + 0.13 / 9.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 10.0 / 1.9 + 0.13 / 8.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 9.0 / 1.9 + 0.13 / 7.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 8.0 / 1.9 + 0.13 / 6.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 12.0 / 1.8 + 0.13 / 10.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 11.0 / 1.8 + 0.13 / 9.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 10.0 / 1.8 + 0.13 / 8.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 9.0 / 1.8 + 0.13 / 7.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 8.0 / 1.8 + 0.13 / 6.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 12.0 / 1.7 + 0.13 / 10.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 11.0 / 1.7 + 0.13 / 9.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 10.0 / 1.7 + 0.13 / 8.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 9.0 / 1.7 + 0.13 / 7.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 8.0 / 1.7 + 0.13 / 6.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 12.0 / 1.6 + 0.13 / 10.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 11.0 / 1.6 + 0.13 / 9.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 10.0 / 1.6 + 0.13 / 8.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 9.0 / 1.6 + 0.13 / 7.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
47%	.20 / 8.0 / 1.6 + 0.13 / 6.0	390	7126	332	98.0%	83.0%	97.1%	975	227	11.0%	0	11.0%
49%	.20 / 12.0 / 1.5 + 0.13 / 10.0	390	7138	332	98.0%	83.1%	97.1%	1017	227	11.0%	48	13.3%
49%	.20 / 11.0 / 1.5 + 0.13 / 9.0	390	7138	332	98.0%	83.1%	97.1%	1017	227	11.0%	48	13.3%
49%	.20 / 10.0 / 1.5 + 0.13 / 8.0	390	7138	332	98.0%	83.1%	97.1%	1017	227	11.0%	42	13.0%
49%	.20 / 9.0 / 1.5 + 0.13 / 7.0	390	7138	332	98.0%	83.1%	97.1%	1017	227	11.0%	42	13.0%
49%	.20 / 8.0 / 1.5 + 0.13 / 6.0	390	7138	332	98.0%	83.1%	97.1%	1017	227	11.0%	42	13.0%

* see text in Section 5 for explanation

Appendix E

ASM Cutpoint Tables

Appendix E: ASM Cutpoint Tables

ASM		Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Cutpoints	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
10%	0.80 / 15.0 / 2.5	279	4631	222	70.0%	53.9%	65.0%	215	0	0.0%	6	0.3%
10%	0.80 / 15.0 / 2.4	279	4631	222	70.0%	53.9%	65.0%	215	0	0.0%	6	0.3%
10%	1.00 / 15.0 / 2.4	279	4631	222	70.0%	53.9%	65.0%	215	0	0.0%	6	0.3%
10%	1.20 / 15.0 / 2.4	279	4631	222	70.0%	53.9%	65.0%	215	0	0.0%	6	0.3%
10%	0.80 / 20.0 / 2.5	275	4562	222	69.1%	53.1%	65.0%	209	0	0.0%	6	0.3%
10%	0.80 / 18.0 / 2.5	275	4562	222	69.1%	53.1%	65.0%	209	0	0.0%	6	0.3%
10%	0.80 / 20.0 / 2.4	275	4562	222	69.1%	53.1%	65.0%	209	0	0.0%	6	0.3%
10%	1.00 / 20.0 / 2.4	275	4562	222	69.1%	53.1%	65.0%	209	0	0.0%	6	0.3%
10%	1.20 / 20.0 / 2.4	275	4562	222	69.1%	53.1%	65.0%	209	0	0.0%	6	0.3%
10%	0.80 / 18.0 / 2.4	275	4562	222	69.1%	53.1%	65.0%	209	0	0.0%	6	0.3%
10%	1.00 / 18.0 / 2.4	275	4562	222	69.1%	53.1%	65.0%	209	0	0.0%	6	0.3%
10%	1.20 / 18.0 / 2.4	275	4562	222	69.1%	53.1%	65.0%	209	0	0.0%	6	0.3%
10%	0.80 / 20.0 / 2.2	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	1.00 / 20.0 / 2.2	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	1.20 / 20.0 / 2.2	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	0.80 / 18.0 / 2.2	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	1.00 / 18.0 / 2.2	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	1.20 / 18.0 / 2.2	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	0.80 / 20.0 / 2.1	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	1.00 / 20.0 / 2.1	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	1.20 / 20.0 / 2.1	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	0.80 / 18.0 / 2.1	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	1.00 / 18.0 / 2.1	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	1.20 / 18.0 / 2.1	275	4562	222	69.1%	53.1%	65.0%	215	0	0.0%	6	0.3%
10%	1.00 / 15.0 / 2.5	271	4591	218	68.0%	53.4%	63.6%	209	0	0.0%	6	0.3%
10%	1.20 / 15.0 / 2.5	271	4591	218	68.0%	53.4%	63.6%	209	0	0.0%	6	0.3%
10%	1.00 / 20.0 / 2.5	267	4521	218	67.1%	52.6%	63.6%	203	0	0.0%	6	0.3%
10%	1.20 / 20.0 / 2.5	267	4521	218	67.1%	52.6%	63.6%	203	0	0.0%	6	0.3%
10%	1.00 / 18.0 / 2.5	267	4521	218	67.1%	52.6%	63.6%	203	0	0.0%	6	0.3%
10%	1.20 / 18.0 / 2.5	267	4521	218	67.1%	52.6%	63.6%	203	0	0.0%	6	0.3%
11%	0.60 / 15.0 / 2.5	295	4754	235	74.1%	55.4%	68.7%	233	0	0.0%	6	0.3%
11%	0.60 / 15.0 / 2.4	295	4754	235	74.1%	55.4%	68.7%	233	0	0.0%	6	0.3%
11%	0.60 / 20.0 / 2.5	291	4685	235	73.1%	54.5%	68.7%	227	0	0.0%	6	0.3%
11%	0.60 / 18.0 / 2.5	291	4685	235	73.1%	54.5%	68.7%	227	0	0.0%	6	0.3%
11%	0.60 / 20.0 / 2.4	291	4685	235	73.1%	54.5%	68.7%	227	0	0.0%	6	0.3%
11%	0.60 / 18.0 / 2.4	291	4685	235	73.1%	54.5%	68.7%	227	0	0.0%	6	0.3%

* see Section 5 for explanation

Appendix E: ASM Cutpoint Tables

ASM Failure Rate	Cutpoints	Excess Emissions Identified HC	CO	NOx	Identification Rates HC	CO	NOx	Fails	Errors of Commission	Ec Rate*	Discrepant Failures	Probable Ec Rate
11%	0.60 / 20.0 / 2.2	291	4685	235	73.1%	54.5%	68.7%	233	0	0.0%	6	0.3%
11%	0.60 / 18.0 / 2.2	291	4685	235	73.1%	54.5%	68.7%	233	0	0.0%	6	0.3%
11%	0.60 / 20.0 / 2.1	291	4685	235	73.1%	54.5%	68.7%	233	0	0.0%	6	0.3%
11%	0.60 / 18.0 / 2.1	291	4685	235	73.1%	54.5%	68.7%	233	0	0.0%	6	0.3%
11%	0.80 / 15.0 / 2.0	279	4631	225	70.0%	53.9%	65.9%	227	0	0.0%	6	0.3%
11%	1.00 / 15.0 / 2.0	279	4631	225	70.0%	53.9%	65.9%	227	0	0.0%	6	0.3%
11%	1.20 / 15.0 / 2.0	279	4631	225	70.0%	53.9%	65.9%	227	0	0.0%	6	0.3%
11%	0.80 / 15.0 / 2.2	279	4631	222	70.0%	53.9%	65.0%	221	0	0.0%	6	0.3%
11%	1.00 / 15.0 / 2.2	279	4631	222	70.0%	53.9%	65.0%	221	0	0.0%	6	0.3%
11%	1.20 / 15.0 / 2.2	279	4631	222	70.0%	53.9%	65.0%	221	0	0.0%	6	0.3%
11%	0.80 / 15.0 / 2.1	279	4631	222	70.0%	53.9%	65.0%	221	0	0.0%	6	0.3%
11%	1.00 / 15.0 / 2.1	279	4631	222	70.0%	53.9%	65.0%	221	0	0.0%	6	0.3%
11%	1.20 / 15.0 / 2.1	279	4631	222	70.0%	53.9%	65.0%	221	0	0.0%	6	0.3%
11%	0.80 / 20.0 / 2.0	275	4562	225	69.1%	53.1%	65.9%	221	0	0.0%	6	0.3%
11%	1.00 / 20.0 / 2.0	275	4562	225	69.1%	53.1%	65.9%	221	0	0.0%	6	0.3%
11%	1.20 / 20.0 / 2.0	275	4562	225	69.1%	53.1%	65.9%	221	0	0.0%	6	0.3%
11%	0.80 / 18.0 / 2.0	275	4562	225	69.1%	53.1%	65.9%	221	0	0.0%	6	0.3%
11%	1.00 / 18.0 / 2.0	275	4562	225	69.1%	53.1%	65.9%	221	0	0.0%	6	0.3%
11%	1.20 / 18.0 / 2.0	275	4562	225	69.1%	53.1%	65.9%	221	0	0.0%	6	0.3%
12%	0.60 / 15.0 / 1.9	296	4764	249	74.3%	55.5%	72.8%	257	0	0.0%	6	0.3%
12%	0.60 / 15.0 / 2.0	295	4754	238	74.1%	55.4%	69.6%	245	0	0.0%	6	0.3%
12%	0.60 / 15.0 / 2.2	295	4754	235	74.1%	55.4%	68.7%	239	0	0.0%	6	0.3%
12%	0.60 / 15.0 / 2.1	295	4754	235	74.1%	55.4%	68.7%	239	0	0.0%	6	0.3%
12%	0.60 / 20.0 / 1.9	292	4695	249	73.4%	54.7%	72.8%	251	0	0.0%	6	0.3%
12%	0.60 / 18.0 / 1.9	292	4695	249	73.4%	54.7%	72.8%	251	0	0.0%	6	0.3%
12%	0.60 / 20.0 / 2.0	291	4685	238	73.1%	54.5%	69.6%	239	0	0.0%	6	0.3%
12%	0.60 / 18.0 / 2.0	291	4685	238	73.1%	54.5%	69.6%	239	0	0.0%	6	0.3%
12%	0.80 / 15.0 / 1.9	284	4698	246	71.4%	54.7%	71.8%	245	0	0.0%	6	0.3%
12%	1.00 / 15.0 / 1.9	284	4698	246	71.4%	54.7%	71.8%	245	0	0.0%	6	0.3%
12%	1.20 / 15.0 / 1.9	284	4698	246	71.4%	54.7%	71.8%	245	0	0.0%	6	0.3%
12%	0.80 / 20.0 / 1.9	281	4629	246	70.4%	53.9%	71.8%	239	0	0.0%	6	0.3%
12%	1.00 / 20.0 / 1.9	281	4629	246	70.4%	53.9%	71.8%	239	0	0.0%	6	0.3%
12%	1.20 / 20.0 / 1.9	281	4629	246	70.4%	53.9%	71.8%	239	0	0.0%	6	0.3%
12%	0.80 / 18.0 / 1.9	281	4629	246	70.4%	53.9%	71.8%	239	0	0.0%	6	0.3%
12%	1.00 / 18.0 / 1.9	281	4629	246	70.4%	53.9%	71.8%	239	0	0.0%	6	0.3%
12%	1.20 / 18.0 / 1.9	281	4629	246	70.4%	53.9%	71.8%	239	0	0.0%	6	0.3%

* see Section 5 for explanation

Appendix E: ASM Cutpoint Tables

ASM		Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Cutpoints	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
12%	1.00 / 12.0 / 2.5	271	4648	218	68.0%	54.1%	63.6%	257	42	2.0%	6	2.3%
12%	1.20 / 12.0 / 2.5	271	4648	218	68.0%	54.1%	63.6%	257	42	2.0%	6	2.3%
13%	0.60 / 20.0 / 1.7	297	4851	267	74.4%	56.5%	77.9%	275	0	0.0%	6	0.3%
13%	0.60 / 18.0 / 1.7	297	4851	267	74.4%	56.5%	77.9%	275	0	0.0%	6	0.3%
13%	0.80 / 15.0 / 1.7	289	4853	263	72.5%	56.5%	76.8%	269	0	0.0%	6	0.3%
13%	1.00 / 15.0 / 1.7	289	4853	263	72.5%	56.5%	76.8%	269	0	0.0%	6	0.3%
13%	1.20 / 15.0 / 1.7	289	4853	263	72.5%	56.5%	76.8%	269	0	0.0%	6	0.3%
13%	0.80 / 20.0 / 1.7	285	4784	263	71.5%	55.7%	76.8%	263	0	0.0%	6	0.3%
13%	1.00 / 20.0 / 1.7	285	4784	263	71.5%	55.7%	76.8%	263	0	0.0%	6	0.3%
13%	1.20 / 20.0 / 1.7	285	4784	263	71.5%	55.7%	76.8%	263	0	0.0%	6	0.3%
13%	0.80 / 18.0 / 1.7	285	4784	263	71.5%	55.7%	76.8%	263	0	0.0%	6	0.3%
13%	1.00 / 18.0 / 1.7	285	4784	263	71.5%	55.7%	76.8%	263	0	0.0%	6	0.3%
13%	1.20 / 18.0 / 1.7	285	4784	263	71.5%	55.7%	76.8%	263	0	0.0%	6	0.3%
13%	0.80 / 10.0 / 2.5	281	4743	222	70.5%	55.2%	65.0%	269	42	2.0%	6	2.3%
13%	0.80 / 10.0 / 2.4	281	4743	222	70.5%	55.2%	65.0%	269	42	2.0%	6	2.3%
13%	1.00 / 10.0 / 2.4	281	4743	222	70.5%	55.2%	65.0%	269	42	2.0%	6	2.3%
13%	1.20 / 10.0 / 2.4	281	4743	222	70.5%	55.2%	65.0%	269	42	2.0%	6	2.3%
13%	0.80 / 10.0 / 2.2	281	4743	222	70.5%	55.2%	65.0%	275	42	2.0%	6	2.3%
13%	1.00 / 10.0 / 2.2	281	4743	222	70.5%	55.2%	65.0%	275	42	2.0%	6	2.3%
13%	1.20 / 10.0 / 2.2	281	4743	222	70.5%	55.2%	65.0%	275	42	2.0%	6	2.3%
13%	0.80 / 10.0 / 2.1	281	4743	222	70.5%	55.2%	65.0%	275	42	2.0%	6	2.3%
13%	1.00 / 10.0 / 2.1	281	4743	222	70.5%	55.2%	65.0%	275	42	2.0%	6	2.3%
13%	1.20 / 10.0 / 2.1	281	4743	222	70.5%	55.2%	65.0%	275	42	2.0%	6	2.3%
13%	0.80 / 12.0 / 2.0	279	4689	225	70.0%	54.6%	65.9%	275	42	2.0%	6	2.3%
13%	1.00 / 12.0 / 2.0	279	4689	225	70.0%	54.6%	65.9%	275	42	2.0%	6	2.3%
13%	0.80 / 12.0 / 2.0	279	4689	225	70.0%	54.6%	65.9%	275	42	2.0%	6	2.3%
13%	1.00 / 12.0 / 2.0	279	4689	225	70.0%	54.6%	65.9%	275	42	2.0%	6	2.3%
13%	1.20 / 12.0 / 2.0	279	4689	225	70.0%	54.6%	65.9%	275	42	2.0%	6	2.3%
13%	0.80 / 12.0 / 2.5	279	4689	222	70.0%	54.6%	65.0%	263	42	2.0%	6	2.3%
13%	0.80 / 12.0 / 2.4	279	4689	222	70.0%	54.6%	65.0%	263	42	2.0%	6	2.3%
13%	1.00 / 12.0 / 2.4	279	4689	222	70.0%	54.6%	65.0%	263	42	2.0%	6	2.3%
13%	1.20 / 12.0 / 2.4	279	4689	222	70.0%	54.6%	65.0%	263	42	2.0%	6	2.3%
13%	0.80 / 12.0 / 2.2	279	4689	222	70.0%	54.6%	65.0%	269	42	2.0%	6	2.3%
13%	1.00 / 12.0 / 2.2	279	4689	222	70.0%	54.6%	65.0%	269	42	2.0%	6	2.3%
13%	1.20 / 12.0 / 2.2	279	4689	222	70.0%	54.6%	65.0%	269	42	2.0%	6	2.3%
13%	0.80 / 12.0 / 2.1	279	4689	222	70.0%	54.6%	65.0%	269	42	2.0%	6	2.3%

* see Section 5 for explanation

Appendix E: ASM Cutpoint Tables

ASM Failure Rate	Cutpoints	Excess Emissions Identified HC	CO	NOx	Identification Rates HC	CO	NOx	Fails	Errors of Commission	Ec Rate*	Discrepant Failures	Probable Ec Rate
13%	1.00 / 12.0 / 2.1	279	4689	222	70.0%	54.6%	65.0%	269	42	2.0%	6	2.3%
13%	1.20 / 12.0 / 2.1	279	4689	222	70.0%	54.6%	65.0%	269	42	2.0%	6	2.3%
13%	1.00 / 10.0 / 2.5	273	4702	218	68.5%	54.7%	63.6%	263	42	2.0%	6	2.3%
13%	1.20 / 10.0 / 2.5	273	4702	218	68.5%	54.7%	63.6%	263	42	2.0%	6	2.3%
14%	0.60 / 15.0 / 1.7	300	4920	267	75.4%	57.3%	77.9%	281	0	0.0%	6	0.3%
14%	0.60 / 11.0 / 2.0	297	4866	238	74.5%	56.7%	69.6%	299	42	2.0%	6	2.3%
14%	0.60 / 10.0 / 2.0	297	4866	238	74.5%	56.7%	69.6%	299	42	2.0%	6	2.3%
14%	0.60 / 9.0 / 2.0	297	4866	238	74.5%	56.7%	69.6%	299	42	2.0%	6	2.3%
14%	0.60 / 10.0 / 2.0	297	4866	238	74.5%	56.7%	69.6%	299	42	2.0%	6	2.3%
14%	0.60 / 10.0 / 2.5	297	4866	235	74.5%	56.7%	68.7%	287	42	2.0%	6	2.3%
14%	0.60 / 10.0 / 2.4	297	4866	235	74.5%	56.7%	68.7%	287	42	2.0%	6	2.3%
14%	0.60 / 10.0 / 2.2	297	4866	235	74.5%	56.7%	68.7%	293	42	2.0%	6	2.3%
14%	0.60 / 10.0 / 2.1	297	4866	235	74.5%	56.7%	68.7%	293	42	2.0%	6	2.3%
14%	0.60 / 12.0 / 2.0	295	4812	238	74.1%	56.0%	69.6%	293	42	2.0%	6	2.3%
14%	0.60 / 12.0 / 2.0	295	4812	238	74.1%	56.0%	69.6%	293	42	2.0%	6	2.3%
14%	0.60 / 12.0 / 2.5	295	4812	235	74.1%	56.0%	68.7%	281	42	2.0%	6	2.3%
14%	0.60 / 12.0 / 2.4	295	4812	235	74.1%	56.0%	68.7%	281	42	2.0%	6	2.3%
14%	0.60 / 12.0 / 2.2	295	4812	235	74.1%	56.0%	68.7%	287	42	2.0%	6	2.3%
14%	0.60 / 12.0 / 2.1	295	4812	235	74.1%	56.0%	68.7%	287	42	2.0%	6	2.3%
14%	0.80 / 11.0 / 1.80	286	4810	246	71.8%	56.0%	71.8%	299	42	2.0%	6	2.3%
14%	1.00 / 11.0 / 1.80	286	4810	246	71.8%	56.0%	71.8%	299	42	2.0%	6	2.3%
14%	0.80 / 10.0 / 1.80	286	4810	246	71.8%	56.0%	71.8%	299	42	2.0%	6	2.3%
14%	1.00 / 10.0 / 1.80	286	4810	246	71.8%	56.0%	71.8%	299	42	2.0%	6	2.3%
14%	0.80 / 9.0 / 1.80	286	4810	246	71.8%	56.0%	71.8%	299	42	2.0%	6	2.3%
14%	1.00 / 9.0 / 1.80	286	4810	246	71.8%	56.0%	71.8%	299	42	2.0%	6	2.3%
14%	0.80 / 10.0 / 1.9	286	4810	246	71.8%	56.0%	71.8%	299	42	2.0%	6	2.3%
14%	1.00 / 10.0 / 1.9	286	4810	246	71.8%	56.0%	71.8%	299	42	2.0%	6	2.3%
14%	1.20 / 10.0 / 1.9	286	4810	246	71.8%	56.0%	71.8%	299	42	2.0%	6	2.3%
14%	0.80 / 12.0 / 1.80	284	4756	246	71.4%	55.4%	71.8%	293	42	2.0%	6	2.3%
14%	1.00 / 12.0 / 1.80	284	4756	246	71.4%	55.4%	71.8%	293	42	2.0%	6	2.3%
14%	0.80 / 12.0 / 1.9	284	4756	246	71.4%	55.4%	71.8%	293	42	2.0%	6	2.3%
14%	1.00 / 12.0 / 1.9	284	4756	246	71.4%	55.4%	71.8%	293	42	2.0%	6	2.3%
14%	1.20 / 12.0 / 1.9	284	4756	246	71.4%	55.4%	71.8%	293	42	2.0%	6	2.3%
14%	0.80 / 11.0 / 2.0	281	4743	225	70.5%	55.2%	65.9%	281	42	2.0%	6	2.3%
14%	1.00 / 11.0 / 2.0	281	4743	225	70.5%	55.2%	65.9%	281	42	2.0%	6	2.3%
14%	0.80 / 10.0 / 2.0	281	4743	225	70.5%	55.2%	65.9%	281	42	2.0%	6	2.3%

* see Section 5 for explanation

Appendix E: ASM Cutpoint Tables

ASM Failure Rate	Cutpoints	Excess Emissions Identified HC	CO	NOx	Identification Rates HC	CO	NOx	Fails	Errors of Commission	Ec Rate*	Discrepant Failures	Probable Ec Rate
14%	1.00 / 10.0 / 2.0	281	4743	225	70.5%	55.2%	65.9%	281	42	2.0%	6	2.3%
14%	0.80 / 9.0 / 2.0	281	4743	225	70.5%	55.2%	65.9%	281	42	2.0%	6	2.3%
14%	1.00 / 9.0 / 2.0	281	4743	225	70.5%	55.2%	65.9%	281	42	2.0%	6	2.3%
14%	0.80 / 10.0 / 2.0	281	4743	225	70.5%	55.2%	65.9%	281	42	2.0%	6	2.3%
14%	1.00 / 10.0 / 2.0	281	4743	225	70.5%	55.2%	65.9%	281	42	2.0%	6	2.3%
14%	1.20 / 10.0 / 2.0	281	4743	225	70.5%	55.2%	65.9%	281	42	2.0%	6	2.3%
15%	0.60 / 11.0 / 1.80	298	4876	249	74.8%	56.8%	72.8%	311	42	2.0%	6	2.3%
15%	0.60 / 10.0 / 1.80	298	4876	249	74.8%	56.8%	72.8%	311	42	2.0%	6	2.3%
15%	0.60 / 9.0 / 1.80	298	4876	249	74.8%	56.8%	72.8%	311	42	2.0%	6	2.3%
15%	0.60 / 10.0 / 1.9	298	4876	249	74.8%	56.8%	72.8%	311	42	2.0%	6	2.3%
15%	0.60 / 12.0 / 1.80	296	4822	249	74.3%	56.1%	72.8%	305	42	2.0%	6	2.3%
15%	0.60 / 12.0 / 1.9	296	4822	249	74.3%	56.1%	72.8%	305	42	2.0%	6	2.3%
15%	0.80 / 12.0 / 1.7	289	4911	263	72.5%	57.2%	76.8%	317	42	2.0%	6	2.3%
15%	1.00 / 12.0 / 1.7	289	4911	263	72.5%	57.2%	76.8%	317	42	2.0%	6	2.3%
15%	1.20 / 12.0 / 1.7	289	4911	263	72.5%	57.2%	76.8%	317	42	2.0%	6	2.3%
16%	0.60 / 10.0 / 1.7	302	5032	267	75.8%	58.6%	77.9%	335	42	2.0%	6	2.3%
16%	0.60 / 12.0 / 1.7	300	4978	267	75.4%	58.0%	77.9%	329	42	2.0%	6	2.3%
16%	0.80 / 10.0 / 1.7	291	4965	263	72.9%	57.8%	76.8%	323	42	2.0%	6	2.3%
16%	1.00 / 10.0 / 1.7	291	4965	263	72.9%	57.8%	76.8%	323	42	2.0%	6	2.3%
16%	1.20 / 10.0 / 1.7	291	4965	263	72.9%	57.8%	76.8%	323	42	2.0%	6	2.3%
18%	0.80 / 8.0 / 2.0	298	5251	233	74.7%	61.1%	68.0%	377	42	2.0%	6	2.3%
18%	1.00 / 8.0 / 2.0	298	5251	233	74.7%	61.1%	68.0%	377	42	2.0%	6	2.3%
19%	0.40 / 20.0 / 2.0	316	5100	241	79.4%	59.4%	70.3%	400	6	0.3%	6	0.6%
19%	0.40 / 18.0 / 2.0	316	5100	241	79.4%	59.4%	70.3%	400	6	0.3%	6	0.6%
19%	0.40 / 15.0 / 2.0	316	5100	241	79.4%	59.4%	70.3%	400	6	0.3%	6	0.6%
19%	0.40 / 20.0 / 2.5	316	5100	237	79.4%	59.4%	69.4%	388	6	0.3%	6	0.6%
19%	0.40 / 18.0 / 2.5	316	5100	237	79.4%	59.4%	69.4%	388	6	0.3%	6	0.6%
19%	0.40 / 15.0 / 2.5	316	5100	237	79.4%	59.4%	69.4%	388	6	0.3%	6	0.6%
19%	0.40 / 20.0 / 2.4	316	5100	237	79.4%	59.4%	69.4%	388	6	0.3%	6	0.6%
19%	0.40 / 18.0 / 2.4	316	5100	237	79.4%	59.4%	69.4%	388	6	0.3%	6	0.6%
19%	0.40 / 15.0 / 2.4	316	5100	237	79.4%	59.4%	69.4%	388	6	0.3%	6	0.6%
19%	0.40 / 20.0 / 2.2	316	5100	237	79.4%	59.4%	69.4%	394	6	0.3%	6	0.6%
19%	0.40 / 18.0 / 2.2	316	5100	237	79.4%	59.4%	69.4%	394	6	0.3%	6	0.6%
19%	0.40 / 15.0 / 2.2	316	5100	237	79.4%	59.4%	69.4%	394	6	0.3%	6	0.6%
19%	0.40 / 20.0 / 2.1	316	5100	237	79.4%	59.4%	69.4%	394	6	0.3%	6	0.6%
19%	0.40 / 18.0 / 2.1	316	5100	237	79.4%	59.4%	69.4%	394	6	0.3%	6	0.6%

* see Section 5 for explanation

Appendix E: ASM Cutpoint Tables

ASM Failure Rate	Cutpoints	Excess Emissions Identified HC	CO	NOx	Identification Rates HC	CO	NOx	Fails	Errors of Commission	Ec Rate*	Discrepant Failures	Probable Ec Rate
19%	0.40 / 15.0 / 2.1	316	5100	237	79.4%	59.4%	69.4%	394	6	0.3%	6	0.6%
19%	0.60 / 8.0 / 2.0	314	5375	245	78.7%	62.6%	71.7%	394	42	2.0%	6	2.3%
19%	0.60 / 11.0 / 1.50	313	5282	274	78.5%	61.5%	80.1%	400	42	2.0%	48	4.3%
19%	0.60 / 10.0 / 1.50	313	5282	274	78.5%	61.5%	80.1%	400	42	2.0%	48	4.3%
19%	0.60 / 9.0 / 1.50	313	5282	274	78.5%	61.5%	80.1%	400	42	2.0%	48	4.3%
19%	0.60 / 12.0 / 1.50	311	5228	274	78.0%	60.9%	80.1%	394	42	2.0%	48	4.3%
19%	0.80 / 11.0 / 1.50	306	5272	274	76.8%	61.4%	80.0%	394	42	2.0%	48	4.3%
19%	1.00 / 11.0 / 1.50	306	5272	274	76.8%	61.4%	80.0%	394	42	2.0%	48	4.3%
19%	0.80 / 10.0 / 1.50	306	5272	274	76.8%	61.4%	80.0%	394	42	2.0%	48	4.3%
19%	1.00 / 10.0 / 1.50	306	5272	274	76.8%	61.4%	80.0%	394	42	2.0%	48	4.3%
19%	0.80 / 9.0 / 1.50	306	5272	274	76.8%	61.4%	80.0%	394	42	2.0%	48	4.3%
19%	1.00 / 9.0 / 1.50	306	5272	274	76.8%	61.4%	80.0%	394	42	2.0%	48	4.3%
19%	0.80 / 12.0 / 1.50	304	5218	274	76.3%	60.8%	80.0%	388	42	2.0%	48	4.3%
19%	1.00 / 12.0 / 1.50	304	5218	274	76.3%	60.8%	80.0%	388	42	2.0%	48	4.3%
19%	0.80 / 8.0 / 1.80	303	5318	253	76.0%	61.9%	73.9%	394	42	2.0%	6	2.3%
19%	1.00 / 8.0 / 1.80	303	5318	253	76.0%	61.9%	73.9%	394	42	2.0%	6	2.3%
20%	0.40 / 20.0 / 1.9	317	5110	252	79.6%	59.5%	73.5%	412	6	0.3%	6	0.6%
20%	0.40 / 18.0 / 1.9	317	5110	252	79.6%	59.5%	73.5%	412	6	0.3%	6	0.6%
20%	0.40 / 15.0 / 1.9	317	5110	252	79.6%	59.5%	73.5%	412	6	0.3%	6	0.6%
20%	0.60 / 8.0 / 1.80	315	5385	257	78.9%	62.7%	75.0%	406	42	2.0%	6	2.3%
21%	0.40 / 20.0 / 1.7	321	5266	269	80.7%	61.3%	78.6%	436	6	0.3%	6	0.6%
21%	0.40 / 18.0 / 1.7	321	5266	269	80.7%	61.3%	78.6%	436	6	0.3%	6	0.6%
21%	0.40 / 15.0 / 1.7	321	5266	269	80.7%	61.3%	78.6%	436	6	0.3%	6	0.6%
21%	0.40 / 10.0 / 2.5	318	5212	237	79.8%	60.7%	69.4%	442	48	2.3%	6	2.6%
21%	0.40 / 10.0 / 2.4	318	5212	237	79.8%	60.7%	69.4%	442	48	2.3%	6	2.6%
21%	0.40 / 12.0 / 2.5	316	5158	237	79.4%	60.1%	69.4%	436	48	2.3%	6	2.6%
21%	0.40 / 12.0 / 2.4	316	5158	237	79.4%	60.1%	69.4%	436	48	2.3%	6	2.6%
21%	0.40 / 12.0 / 2.2	316	5158	237	79.4%	60.1%	69.4%	442	48	2.3%	6	2.6%
21%	0.40 / 12.0 / 2.1	316	5158	237	79.4%	60.1%	69.4%	442	48	2.3%	6	2.6%
22%	0.40 / 11.0 / 2.0	318	5212	241	79.8%	60.7%	70.3%	454	48	2.3%	6	2.6%
22%	0.40 / 10.0 / 2.0	318	5212	241	79.8%	60.7%	70.3%	454	48	2.3%	6	2.6%
22%	0.40 / 9.0 / 2.0	318	5212	241	79.8%	60.7%	70.3%	454	48	2.3%	6	2.6%
22%	0.40 / 10.0 / 2.0	318	5212	241	79.8%	60.7%	70.3%	454	48	2.3%	6	2.6%
22%	0.40 / 10.0 / 2.2	318	5212	237	79.8%	60.7%	69.4%	448	48	2.3%	6	2.6%
22%	0.40 / 10.0 / 2.1	318	5212	237	79.8%	60.7%	69.4%	448	48	2.3%	6	2.6%
22%	0.40 / 12.0 / 1.80	317	5168	252	79.6%	60.2%	73.5%	460	48	2.3%	6	2.6%

* see Section 5 for explanation

Appendix E: ASM Cutpoint Tables

ASM		Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Cutpoints	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
22%	0.40 / 12.0 / 1.9	317	5168	252	79.6%	60.2%	73.5%	460	48	2.3%	6	2.6%
22%	0.40 / 12.0 / 2.0	316	5158	241	79.4%	60.1%	70.3%	448	48	2.3%	6	2.6%
22%	0.40 / 12.0 / 2.0	316	5158	241	79.4%	60.1%	70.3%	448	48	2.3%	6	2.6%
23%	0.60 / 8.0 / 1.50	324	5659	274	81.2%	65.9%	80.1%	484	42	2.0%	48	4.3%
23%	0.40 / 12.0 / 1.7	321	5323	269	80.7%	62.0%	78.6%	484	48	2.3%	6	2.6%
23%	0.40 / 11.0 / 1.80	319	5222	252	80.1%	60.8%	73.5%	466	48	2.3%	6	2.6%
23%	0.40 / 10.0 / 1.80	319	5222	252	80.1%	60.8%	73.5%	466	48	2.3%	6	2.6%
23%	0.40 / 9.0 / 1.80	319	5222	252	80.1%	60.8%	73.5%	466	48	2.3%	6	2.6%
23%	0.40 / 10.0 / 1.9	319	5222	252	80.1%	60.8%	73.5%	466	48	2.3%	6	2.6%
23%	0.80 / 8.0 / 1.50	317	5649	274	79.5%	65.8%	80.0%	478	42	2.0%	48	4.3%
23%	1.00 / 8.0 / 1.50	317	5649	274	79.5%	65.8%	80.0%	478	42	2.0%	48	4.3%
24%	0.60 / 11.0 / 1.40	327	5694	306	82.1%	66.3%	89.5%	502	84	4.0%	48	6.4%
24%	0.60 / 10.0 / 1.40	327	5694	306	82.1%	66.3%	89.5%	502	84	4.0%	48	6.4%
24%	0.60 / 9.0 / 1.40	327	5694	306	82.1%	66.3%	89.5%	502	84	4.0%	48	6.4%
24%	0.60 / 12.0 / 1.40	325	5640	306	81.6%	65.7%	89.5%	496	84	4.0%	48	6.4%
24%	0.40 / 8.0 / 2.0	324	5572	246	81.4%	64.9%	71.8%	502	48	2.3%	6	2.6%
24%	0.40 / 10.0 / 1.7	323	5377	269	81.1%	62.6%	78.6%	490	48	2.3%	6	2.6%
24%	0.80 / 11.0 / 1.40	320	5684	306	80.4%	66.2%	89.4%	496	84	4.0%	48	6.4%
24%	1.00 / 11.0 / 1.40	320	5684	306	80.4%	66.2%	89.4%	496	84	4.0%	48	6.4%
24%	0.80 / 10.0 / 1.40	320	5684	306	80.4%	66.2%	89.4%	496	84	4.0%	48	6.4%
24%	1.00 / 10.0 / 1.40	320	5684	306	80.4%	66.2%	89.4%	496	84	4.0%	48	6.4%
24%	0.80 / 9.0 / 1.40	320	5684	306	80.4%	66.2%	89.4%	496	84	4.0%	48	6.4%
24%	1.00 / 9.0 / 1.40	320	5684	306	80.4%	66.2%	89.4%	496	84	4.0%	48	6.4%
24%	0.80 / 12.0 / 1.40	318	5630	306	79.9%	65.5%	89.4%	490	84	4.0%	48	6.4%
24%	1.00 / 12.0 / 1.40	318	5630	306	79.9%	65.5%	89.4%	490	84	4.0%	48	6.4%
25%	0.40 / 8.0 / 1.80	325	5582	257	81.6%	65.0%	75.1%	514	48	2.3%	6	2.6%
26%	0.60 / 11.0 / 1.30	327	5706	306	82.1%	66.4%	89.5%	544	84	4.0%	90	8.4%
26%	0.60 / 10.0 / 1.30	327	5706	306	82.1%	66.4%	89.5%	544	84	4.0%	90	8.4%
26%	0.60 / 9.0 / 1.30	327	5706	306	82.1%	66.4%	89.5%	544	84	4.0%	90	8.4%
26%	0.60 / 12.0 / 1.30	325	5652	306	81.6%	65.8%	89.5%	538	84	4.0%	90	8.4%
26%	0.40 / 11.0 / 1.50	324	5472	274	81.4%	63.7%	80.1%	544	48	2.3%	48	4.6%
26%	0.40 / 10.0 / 1.50	324	5472	274	81.4%	63.7%	80.1%	544	48	2.3%	48	4.6%
26%	0.40 / 9.0 / 1.50	324	5472	274	81.4%	63.7%	80.1%	544	48	2.3%	48	4.6%
26%	0.40 / 12.0 / 1.50	323	5418	274	80.9%	63.1%	80.1%	538	48	2.3%	48	4.6%
26%	0.80 / 11.0 / 1.30	320	5696	306	80.4%	66.3%	89.4%	538	84	4.0%	90	8.4%
26%	1.00 / 11.0 / 1.30	320	5696	306	80.4%	66.3%	89.4%	538	84	4.0%	90	8.4%

* see Section 5 for explanation

Appendix E: ASM Cutpoint Tables

ASM Failure Rate	Cutpoints	Excess Emissions Identified HC	CO	NOx	Identification Rates HC	CO	NOx	Fails	Errors of Commission	Ec Rate*	Discrepant Failures	Probable Ec Rate
26%	0.80 / 10.0 / 1.30	320	5696	306	80.4%	66.3%	89.4%	538	84	4.0%	90	8.4%
26%	1.00 / 10.0 / 1.30	320	5696	306	80.4%	66.3%	89.4%	538	84	4.0%	90	8.4%
26%	0.80 / 9.0 / 1.30	320	5696	306	80.4%	66.3%	89.4%	538	84	4.0%	90	8.4%
26%	1.00 / 9.0 / 1.30	320	5696	306	80.4%	66.3%	89.4%	538	84	4.0%	90	8.4%
26%	0.80 / 12.0 / 1.30	318	5642	306	79.9%	65.7%	89.4%	532	84	4.0%	90	8.4%
26%	1.00 / 12.0 / 1.30	318	5642	306	79.9%	65.7%	89.4%	532	84	4.0%	90	8.4%
27%	0.30 / 12.0 / 1.80	345	5594	262	86.6%	65.1%	76.7%	568	90	4.3%	0	4.3%
27%	0.30 / 11.0 / 1.80	345	5594	262	86.6%	65.1%	76.7%	568	90	4.3%	0	4.3%
27%	0.30 / 10.0 / 1.80	345	5594	262	86.6%	65.1%	76.7%	568	90	4.3%	0	4.3%
27%	0.30 / 9.0 / 1.80	345	5594	262	86.6%	65.1%	76.7%	568	90	4.3%	0	4.3%
27%	0.30 / 12.0 / 2.0	344	5584	251	86.4%	65.0%	73.4%	556	90	4.3%	0	4.3%
27%	0.30 / 11.0 / 2.0	344	5584	251	86.4%	65.0%	73.4%	556	90	4.3%	0	4.3%
27%	0.30 / 10.0 / 2.0	344	5584	251	86.4%	65.0%	73.4%	556	90	4.3%	0	4.3%
27%	0.30 / 9.0 / 2.0	344	5584	251	86.4%	65.0%	73.4%	556	90	4.3%	0	4.3%
28%	0.60 / 8.0 / 1.40	338	6071	306	84.8%	70.7%	89.5%	586	84	4.0%	48	6.4%
28%	0.80 / 8.0 / 1.40	331	6061	306	83.1%	70.6%	89.4%	580	84	4.0%	48	6.4%
28%	1.00 / 8.0 / 1.40	331	6061	306	83.1%	70.6%	89.4%	580	84	4.0%	48	6.4%
28%	0.60 / 12.0 / 1.20	329	5753	308	82.7%	67.0%	89.9%	586	84	4.0%	132	10.4%
28%	0.40 / 8.0 / 1.50	329	5755	274	82.5%	67.0%	80.1%	586	48	2.3%	48	4.6%
28%	0.80 / 11.0 / 1.20	324	5797	308	81.4%	67.5%	89.8%	586	84	4.0%	132	10.4%
28%	1.00 / 11.0 / 1.20	324	5797	308	81.4%	67.5%	89.8%	586	84	4.0%	132	10.4%
28%	0.80 / 10.0 / 1.20	324	5797	308	81.4%	67.5%	89.8%	586	84	4.0%	132	10.4%
28%	1.00 / 10.0 / 1.20	324	5797	308	81.4%	67.5%	89.8%	586	84	4.0%	132	10.4%
28%	0.80 / 9.0 / 1.20	324	5797	308	81.4%	67.5%	89.8%	586	84	4.0%	132	10.4%
28%	1.00 / 9.0 / 1.20	324	5797	308	81.4%	67.5%	89.8%	586	84	4.0%	132	10.4%
28%	0.80 / 12.0 / 1.20	323	5743	308	80.9%	66.9%	89.8%	580	84	4.0%	132	10.4%
28%	1.00 / 12.0 / 1.20	323	5743	308	80.9%	66.9%	89.8%	580	84	4.0%	132	10.4%
29%	0.30 / 8.0 / 2.0	351	5943	256	88.0%	69.2%	74.9%	604	90	4.3%	0	4.3%
29%	0.60 / 11.0 / 1.20	331	5807	308	83.1%	67.6%	89.9%	592	84	4.0%	132	10.4%
29%	0.60 / 10.0 / 1.20	331	5807	308	83.1%	67.6%	89.9%	592	84	4.0%	132	10.4%
29%	0.60 / 9.0 / 1.20	331	5807	308	83.1%	67.6%	89.9%	592	84	4.0%	132	10.4%
30%	0.30 / 8.0 / 1.80	351	5953	268	88.2%	69.3%	78.2%	616	90	4.3%	0	4.3%
30%	0.60 / 8.0 / 1.30	338	6083	306	84.8%	70.8%	89.5%	628	84	4.0%	90	8.4%
30%	0.80 / 8.0 / 1.30	331	6073	306	83.1%	70.7%	89.4%	622	84	4.0%	90	8.4%
30%	1.00 / 8.0 / 1.30	331	6073	306	83.1%	70.7%	89.4%	622	84	4.0%	90	8.4%
31%	0.30 / 12.0 / 1.50	351	5813	283	88.0%	67.7%	82.7%	640	90	4.3%	42	6.4%

* see Section 5 for explanation

Appendix E: ASM Cutpoint Tables

ASM Failure Rate	Cutpoints	Excess Emissions Identified HC	CO	NOx	Identification Rates HC	CO	NOx	Fails	Errors of Commission	Ec Rate*	Discrepant Failures	Probable Ec Rate
31%	0.30 / 11.0 / 1.50	351	5813	283	88.0%	67.7%	82.7%	640	90	4.3%	42	6.4%
31%	0.30 / 10.0 / 1.50	351	5813	283	88.0%	67.7%	82.7%	640	90	4.3%	42	6.4%
31%	0.30 / 9.0 / 1.50	351	5813	283	88.0%	67.7%	82.7%	640	90	4.3%	42	6.4%
31%	0.40 / 11.0 / 1.40	339	5885	306	85.0%	68.5%	89.5%	646	90	4.3%	48	6.6%
31%	0.40 / 10.0 / 1.40	339	5885	306	85.0%	68.5%	89.5%	646	90	4.3%	48	6.6%
31%	0.40 / 9.0 / 1.40	339	5885	306	85.0%	68.5%	89.5%	646	90	4.3%	48	6.6%
31%	0.40 / 12.0 / 1.40	337	5830	306	84.5%	67.9%	89.5%	640	90	4.3%	48	6.6%
32%	0.80 / 8.0 / 1.20	335	6174	308	84.1%	71.9%	89.8%	670	84	4.0%	132	10.4%
32%	1.00 / 8.0 / 1.20	335	6174	308	84.1%	71.9%	89.8%	670	84	4.0%	132	10.4%
33%	0.30 / 8.0 / 1.50	355	6096	283	89.0%	71.0%	82.7%	682	90	4.3%	42	6.4%
33%	0.40 / 8.0 / 1.40	343	6167	306	86.1%	71.8%	89.5%	688	90	4.3%	48	6.6%
33%	0.60 / 8.0 / 1.20	342	6184	308	85.8%	72.0%	89.9%	676	84	4.0%	132	10.4%
33%	0.40 / 11.0 / 1.30	339	5897	306	85.0%	68.7%	89.5%	688	90	4.3%	90	8.7%
33%	0.40 / 10.0 / 1.30	339	5897	306	85.0%	68.7%	89.5%	688	90	4.3%	90	8.7%
33%	0.40 / 9.0 / 1.30	339	5897	306	85.0%	68.7%	89.5%	688	90	4.3%	90	8.7%
33%	0.40 / 12.0 / 1.30	337	5843	306	84.5%	68.0%	89.5%	682	90	4.3%	90	8.7%
35%	0.40 / 8.0 / 1.30	343	6180	306	86.1%	71.9%	89.5%	729	90	4.3%	90	8.7%
35%	0.40 / 12.0 / 1.20	341	5943	308	85.6%	69.2%	89.9%	729	90	4.3%	132	10.7%
36%	0.30 / 12.0 / 1.40	356	6167	306	89.3%	71.8%	89.5%	735	132	6.4%	42	8.4%
36%	0.30 / 11.0 / 1.40	356	6167	306	89.3%	71.8%	89.5%	735	132	6.4%	42	8.4%
36%	0.30 / 10.0 / 1.40	356	6167	306	89.3%	71.8%	89.5%	735	132	6.4%	42	8.4%
36%	0.30 / 9.0 / 1.40	356	6167	306	89.3%	71.8%	89.5%	735	132	6.4%	42	8.4%
36%	0.40 / 11.0 / 1.20	343	5997	308	86.1%	69.8%	89.9%	735	90	4.3%	132	10.7%
36%	0.40 / 10.0 / 1.20	343	5997	308	86.1%	69.8%	89.9%	735	90	4.3%	132	10.7%
36%	0.40 / 9.0 / 1.20	343	5997	308	86.1%	69.8%	89.9%	735	90	4.3%	132	10.7%
38%	0.30 / 8.0 / 1.40	360	6450	306	90.3%	75.1%	89.5%	777	132	6.4%	42	8.4%
38%	0.30 / 12.0 / 1.30	356	6179	306	89.3%	71.9%	89.5%	777	132	6.4%	84	10.4%
38%	0.30 / 11.0 / 1.30	356	6179	306	89.3%	71.9%	89.5%	777	132	6.4%	84	10.4%
38%	0.30 / 10.0 / 1.30	356	6179	306	89.3%	71.9%	89.5%	777	132	6.4%	84	10.4%
38%	0.30 / 9.0 / 1.30	356	6179	306	89.3%	71.9%	89.5%	777	132	6.4%	84	10.4%
38%	0.40 / 8.0 / 1.20	347	6280	308	87.1%	73.1%	89.9%	777	90	4.3%	132	10.7%
40%	0.60 / 11.0 / 1.0	364	6429	325	91.3%	74.9%	95.0%	837	174	8.4%	221	19.1%
40%	0.80 / 11.0 / 1.0	364	6429	325	91.3%	74.9%	95.0%	837	174	8.4%	221	19.1%
40%	1.00 / 11.0 / 1.0	364	6429	325	91.3%	74.9%	95.0%	837	174	8.4%	221	19.1%
40%	0.60 / 10.0 / 1.0	364	6429	325	91.3%	74.9%	95.0%	837	174	8.4%	221	19.1%
40%	0.80 / 10.0 / 1.0	364	6429	325	91.3%	74.9%	95.0%	837	174	8.4%	221	19.1%

* see Section 5 for explanation

Appendix E: ASM Cutpoint Tables

ASM		Excess Emissions Identified			Identification Rates				Errors of		Discrepant	Probable
Failure Rate	Cutpoints	HC	CO	NOx	HC	CO	NOx	Fails	Commission	Ec Rate*	Failures	Ec Rate
40%	1.00 / 10.0 / 1.0	364	6429	325	91.3%	74.9%	95.0%	837	174	8.4%	221	19.1%
40%	0.60 / 9.0 / 1.0	364	6429	325	91.3%	74.9%	95.0%	837	174	8.4%	221	19.1%
40%	0.80 / 9.0 / 1.0	364	6429	325	91.3%	74.9%	95.0%	837	174	8.4%	221	19.1%
40%	1.00 / 9.0 / 1.0	364	6429	325	91.3%	74.9%	95.0%	837	174	8.4%	221	19.1%
40%	0.60 / 12.0 / 1.0	362	6375	325	90.9%	74.2%	95.0%	831	174	8.4%	221	19.1%
40%	0.80 / 12.0 / 1.0	362	6375	325	90.9%	74.2%	95.0%	831	174	8.4%	221	19.1%
40%	1.00 / 12.0 / 1.0	362	6375	325	90.9%	74.2%	95.0%	831	174	8.4%	221	19.1%
40%	0.30 / 12.0 / 1.20	360	6280	308	90.3%	73.1%	89.9%	825	132	6.4%	126	12.4%
40%	0.30 / 11.0 / 1.20	360	6280	308	90.3%	73.1%	89.9%	825	132	6.4%	126	12.4%
40%	0.30 / 10.0 / 1.20	360	6280	308	90.3%	73.1%	89.9%	825	132	6.4%	126	12.4%
40%	0.30 / 9.0 / 1.20	360	6280	308	90.3%	73.1%	89.9%	825	132	6.4%	126	12.4%
40%	0.30 / 8.0 / 1.30	360	6462	306	90.3%	75.2%	89.5%	819	132	6.4%	84	10.4%
42%	0.60 / 8.0 / 1.0	368	6712	325	92.4%	78.1%	95.0%	879	174	8.4%	180	17.1%
42%	0.80 / 8.0 / 1.0	368	6712	325	92.4%	78.1%	95.0%	879	174	8.4%	180	17.1%
42%	1.00 / 8.0 / 1.0	368	6712	325	92.4%	78.1%	95.0%	879	174	8.4%	180	17.1%
42%	0.30 / 8.0 / 1.20	364	6562	308	91.4%	76.4%	89.9%	867	132	6.4%	126	12.4%
43%	0.40 / 11.0 / 1.0	364	6485	325	91.3%	75.5%	95.0%	897	180	8.7%	138	15.3%
43%	0.40 / 10.0 / 1.0	364	6485	325	91.3%	75.5%	95.0%	897	180	8.7%	138	15.3%
43%	0.40 / 9.0 / 1.0	364	6485	325	91.3%	75.5%	95.0%	897	180	8.7%	138	15.3%
43%	0.40 / 12.0 / 1.0	362	6431	325	90.9%	74.9%	95.0%	891	180	8.7%	138	15.3%
45%	0.40 / 8.0 / 1.0	368	6768	325	92.4%	78.8%	95.0%	939	180	8.7%	138	15.3%
46%	0.30 / 12.0 / 1.0	381	6767	325	95.6%	78.8%	95.0%	945	180	8.7%	132	15.0%
46%	0.30 / 11.0 / 1.0	381	6767	325	95.6%	78.8%	95.0%	945	180	8.7%	132	15.0%
46%	0.30 / 10.0 / 1.0	381	6767	325	95.6%	78.8%	95.0%	945	180	8.7%	132	15.0%
46%	0.30 / 9.0 / 1.0	381	6767	325	95.6%	78.8%	95.0%	945	180	8.7%	132	15.0%
48%	0.30 / 8.0 / 1.0	385	7050	325	96.6%	82.1%	95.0%	987	180	8.7%	132	15.0%

* see Section 5 for explanation

Appendix F

Scatter Plots and Regression Tables

Table F-1

Regression Tables

All Vehicles

Dependent Variable is: HC FTP
R^2 = 81.9%
s = 0.6266 with 106 - 2 = 104 DOF

Standard Error: 0.62 g/mi

Source	um of Squares
Regression	184.815
Residual	40.839

Variable	Coefficient	s.e. of Coeff
Constant	-0.118	0.078
HC IM240	1.318	0.061

Dependent Variable is: HC FTP
R^2 = 73.4%
s = 0.7602 with 106 - 2 = 104 DOF

Standard Error: 0.76 g/mi

Source	um of Squares
Regression	165.550
Residual	60.103

Variable	Coefficient	s.e. of Coeff
Constant	-0.056	0.094
HC ASM	2.264	0.134

Dependent Variable is: CO FTP
R^2 = 54.2%
s = 13.47 with 106 - 2 = 104 DOF

Standard Error: 13.4 g/mi

Source	um of Squares
Regression	22318.900
Residual	18857.200

Variable	Coefficient	s.e. of Coeff
Constant	2.625	1.609
CO IM240	0.929	0.084

Dependent Variable is: CO FTP
R^2 = 67.9%
s = 11.27 with 106 - 2 = 104 DOF

Standard Error: 11.2 g/mi

Source	um of Squares
Regression	27959.200
Residual	13216.900

Variable	Coefficient	s.e. of Coeff
Constant	3.358	1.274
CO ASM	0.970	0.065

Dependent Variable is: NOx FTP
R^2 = 69.7%
s = 0.6570 with 106 - 2 = 104 DOF

Standard Error: 0.65 g/mi

Source	um of Squares
Regression	103.202
Residual	44.889

Variable	Coefficient	s.e. of Coeff
Constant	-0.046	0.104
NOx IM240	0.724	0.047

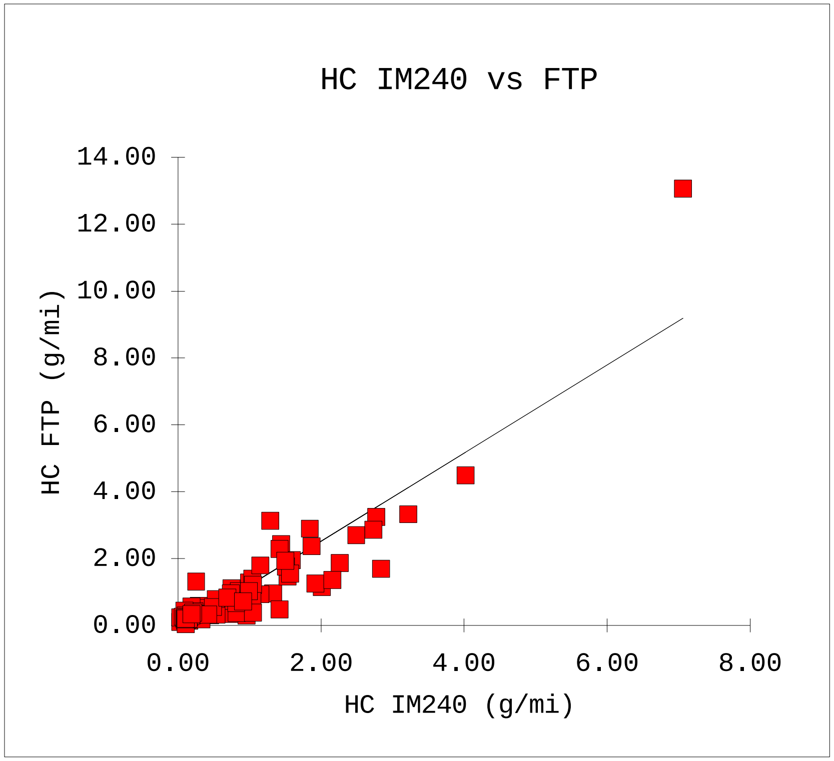
Dependent Variable is: NOx FTP
R^2 = 71.4%
s = 0.6386 with 106 - 2 = 104 DOF

Standard Error: 0.64 g/mi

Source	um of Squares
Regression	105.685
Residual	42.406

Variable	Coefficient	s.e. of Coeff
Constant	-0.002	0.098
NOx ASM	0.831	0.052

<u>Figure F-1</u>
HC Scatterplots
All Vehicles



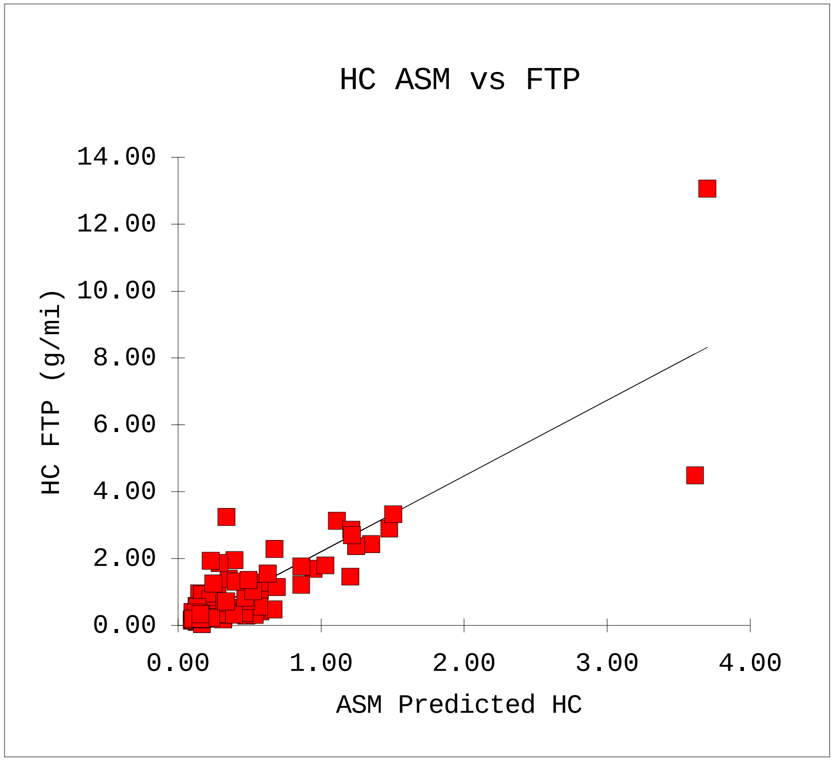
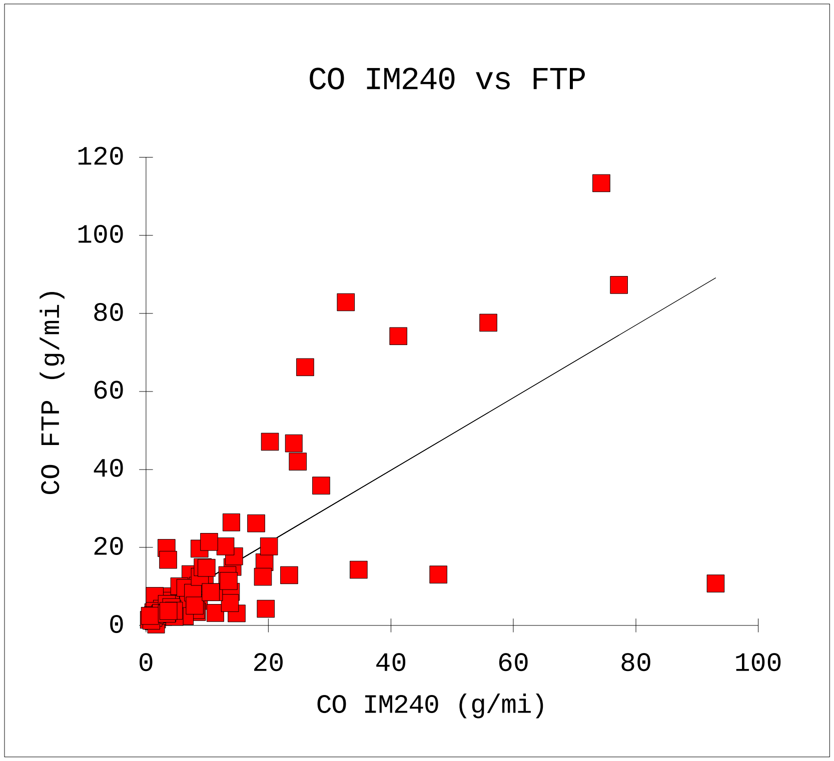


Figure F-2

CO Scatterplots

All Vehicles



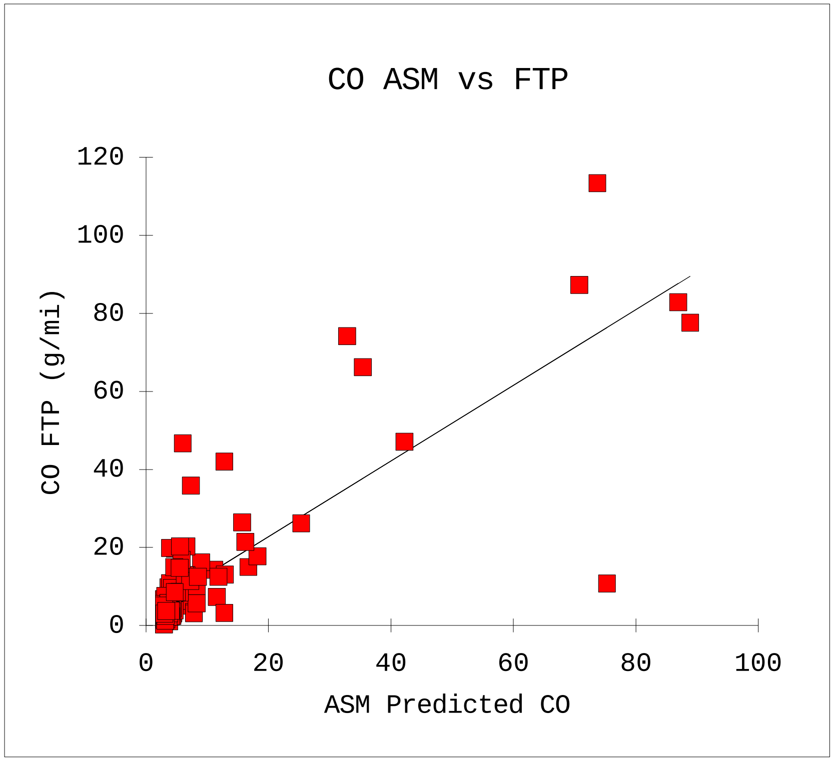
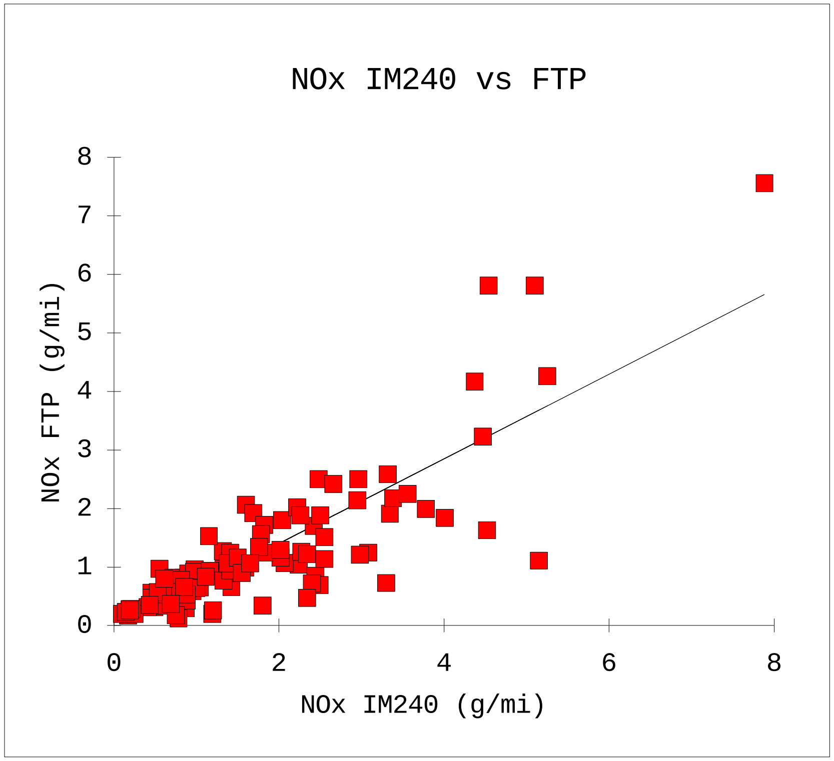
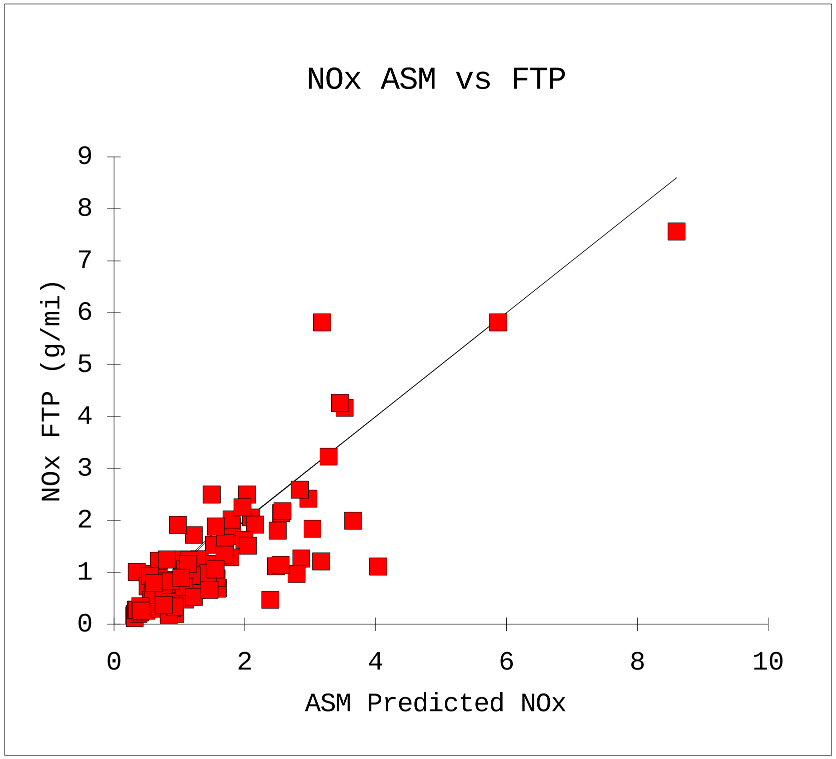


Figure F-3
NOx Scatterplots
All Vehicles





<u>Table F-2</u>

Regression Tables

Vehicle 3211 Removed

Dependent Variable is: HC FTP
R^2 = 82.6%
s = 0.6169 with 105 - 2 = 103 DOF

Standard Error: 0.61 g/mi

Source	ım of Squares
Regression	186.255
Residual	39.194

Variable	Coefficient	s.e. of Coeff
Constant	-0.112	0.077
HC IM240	1.326	0.060

Dependent Variable is: HC FTP
R^2 = 73.8%
s = 0.7578 with 105 - 2 = 105 DOF

Standard Error: 0.75 g/mi

Source	ım of Squares
Regression	166.299
Residual	59.149

Variable	Coefficient	s.e. of Coeff
Constant	-0.050	0.094
HC ASM	2.271	0.133

Dependent Variable is: CO FTP
R^2 = 74.6%
s = 10.08 with 105 - 2 = 103 DOF

Standard Error: 10.0 g/mi

Source	ım of Squares
Regression	30708.400
Residual	10462.600

Variable	Coefficient	s.e. of Coeff
Constant	-0.164	1.243
CO IM240	1.269	0.073

Dependent Variable is: CO FTP
R^2 = 80.2%
s = 8.892 with 105 - 2 = 103 DOF

Standard Error: 8.9 g/mi

Source	ım of Squares
Regression	33027.000
Residual	8144.000

Variable	Coefficient	s.e. of Coeff
Constant	2.394	1.012
CO ASM	1.140	0.056

Dependent Variable is: NOx FTP
R^2 = 69.6%
s = 0.6598 with 105 - 2 = 103 DOF

Standard Error: 0.66 g/mi

Source	ım of Squares
Regression	102.819
Residual	44.834

Variable	Coefficient	s.e. of Coeff
Constant	-0.051	0.106
NOx IM240	0.725	0.047

Dependent Variable is: NOx FTP
R^2 = 71.4%
s = 0.6386 with 105 - 2 = 103 DOF

Standard Error: 0.64 g/mi

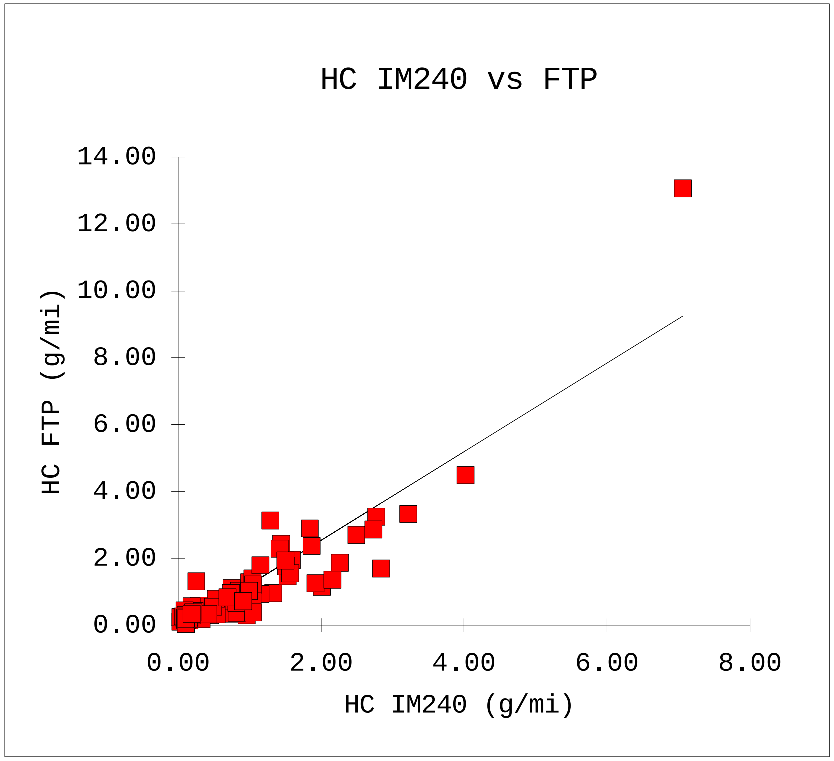
Source	ım of Squares
Regression	105.685
Residual	42.406

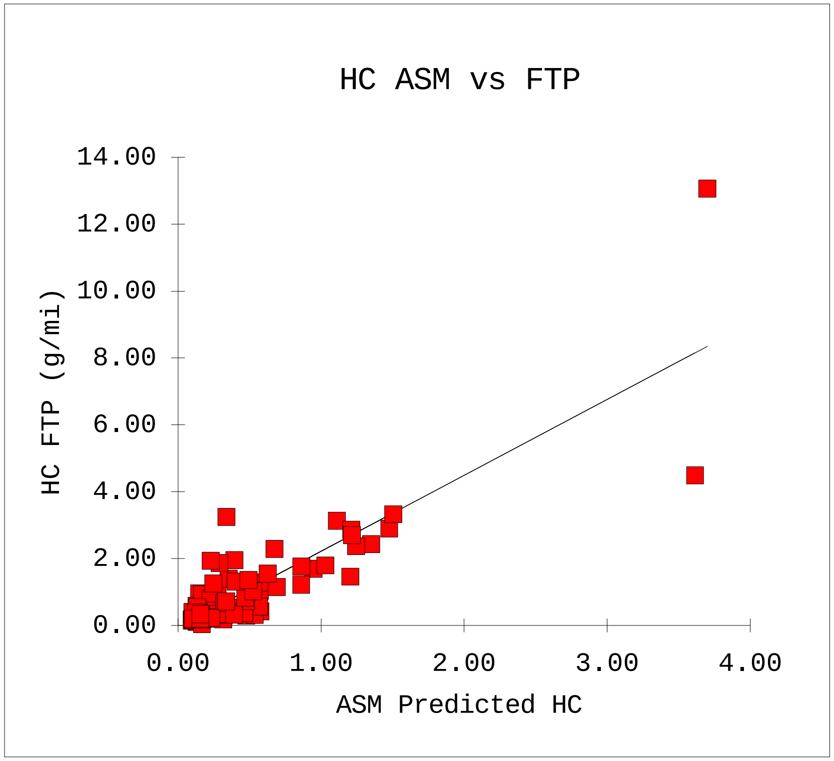
Variable	Coefficient	s.e. of Coeff
Constant	-0.002	0.098
NOx ASM	0.831	0.052

Figure F-4

HC Scatterplots

Vehicle 3211 Removed

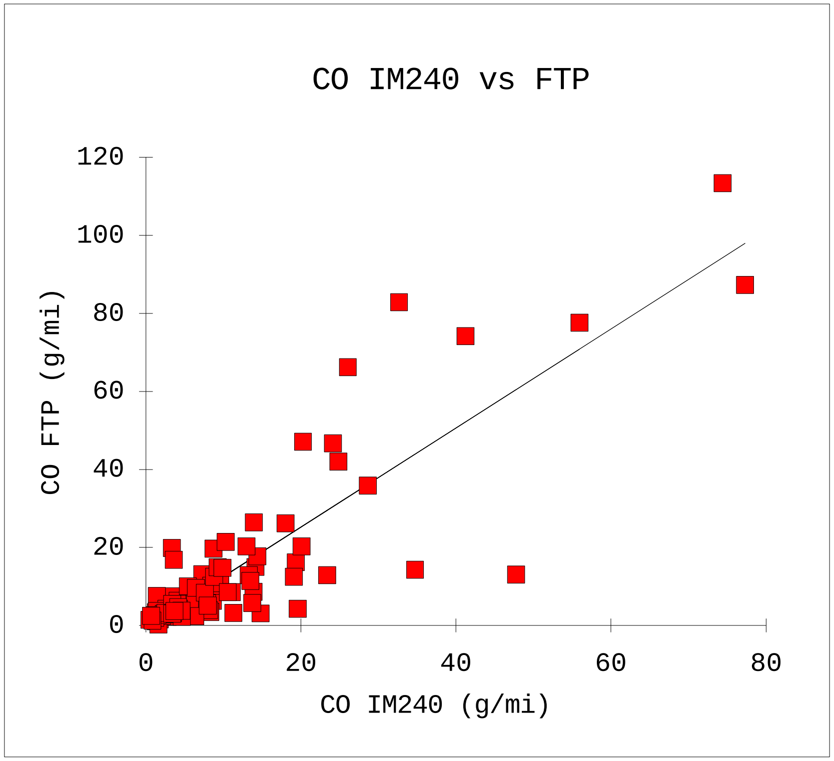




<u>Figure F-5</u>

CO Scatterplots

Vehicle 3211 Removed



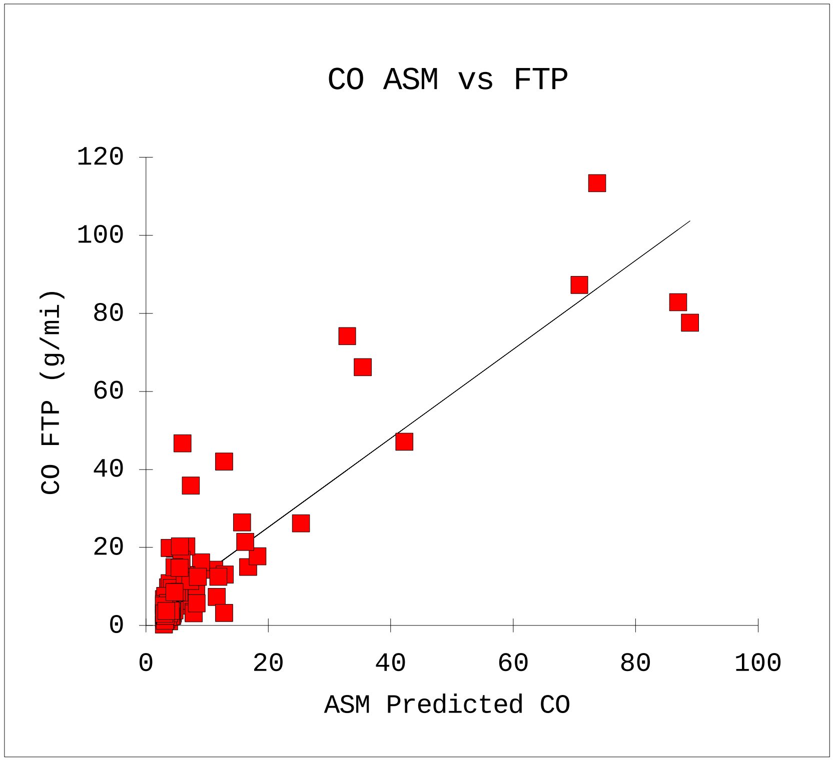
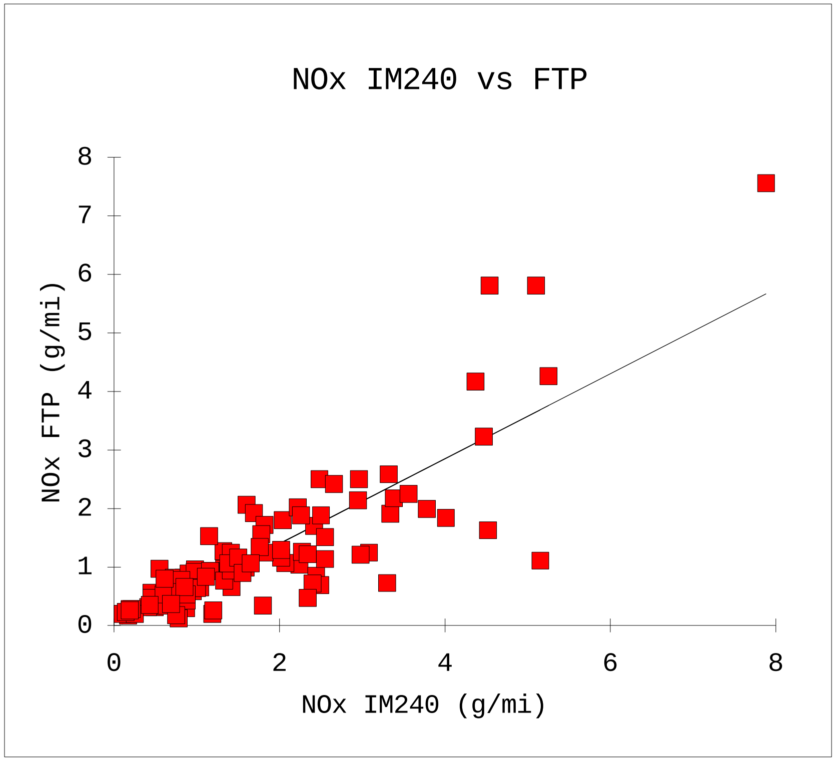


Figure F-6

NOx Scatterplots

Vehicle 3211 Removed



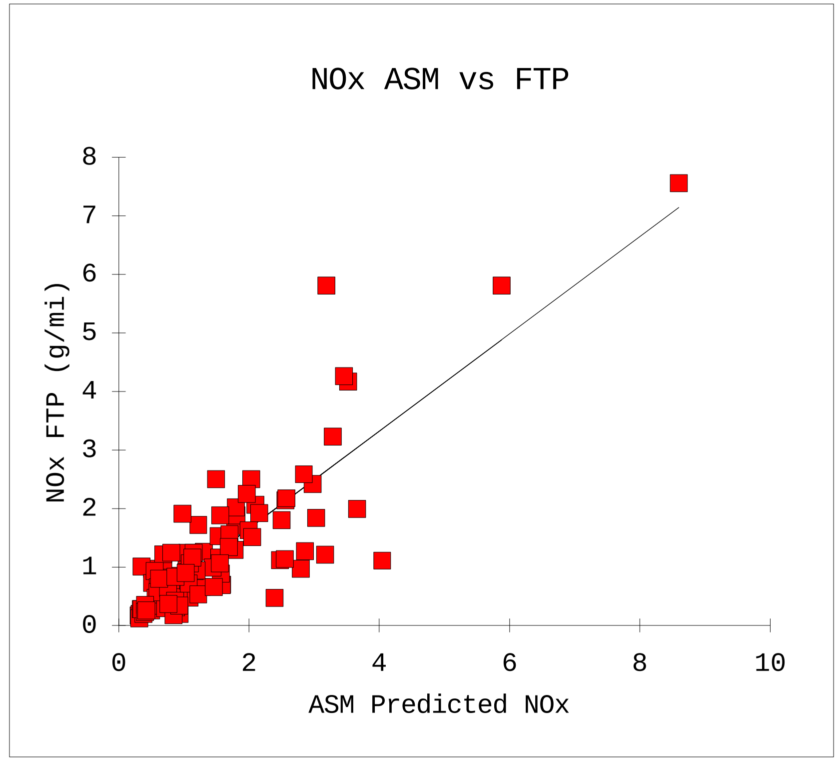


Table F-3

Regression Tables

Vehicles Near Standards

Dependent Variable is: HC FTP
R^2 = 63.0%
s = 0.1953 with 43 - 2 = 41 DOF

Standard Error: 0.19 g/mi

Source	um of Squares
Regression	2.662
Residual	1.563

Variable	Coefficient	s.e. of Coeff
Constant	0.271	0.048
HC IM240	0.531	0.064

Dependent Variable is: HC FTP
R^2 = 17.6%
s = 0.2915 with 43 - 2 = 41 DOF

Standard Error: 0.28 g/mi

Source	um of Squares
Regression	0.742
Residual	3.483

Variable	Coefficient	s.e. of Coeff
Constant	0.342	0.092
HC ASM	0.818	0.277

Dependent Variable is: CO FTP
R^2 = 24.8%
s = 4.360 with 43 - 2 = 41 DOF

Standard Error: 4.3 g/mi

Source	um of Squares
Regression	257.268
Residual	779.566

Variable	Coefficient	s.e. of Coeff
Constant	4.308	1.243
CO IM240	0.490	0.133

Dependent Variable is: CO FTP
R^2 = 13.3%
s = 4.683 with 43 - 2 = 41 DOF

Standard Error: 4.6 g/mi

Source	um of Squares
Regression	137.732
Residual	899.102

Variable	Coefficient	s.e. of Coeff
Constant	4.622	1.586
CO ASM	0.684	0.273

Dependent Variable is: NOx FTP
R^2 = 45.6%
s = 0.3349 with 43 - 2 = 41 DOF

Standard Error: 0.34 g/mi

Source	um of Squares
Regression	3.848
Residual	4.599

Variable	Coefficient	s.e. of Coeff
Constant	0.670	0.103
NOx IM240	0.276	0.047

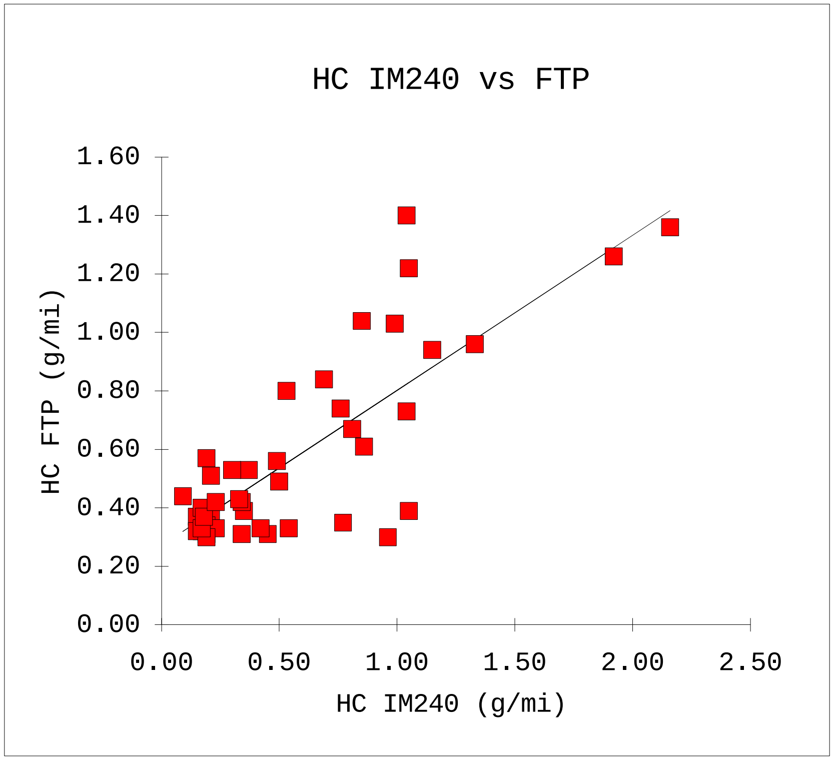
Dependent Variable is: NOx FTP
R^2 = 26.0%
s = 0.3904 with 43 - 2 = 41 DOF

Standard Error: 0.39 g/mi

Source	um of Squares
Regression	2.200
Residual	6.248

Variable	Coefficient	s.e. of Coeff
Constant	0.792	0.121
NOx ASM	0.266	0.070

Figure F-7
HC Scatterplots
Vehicles Near Standards



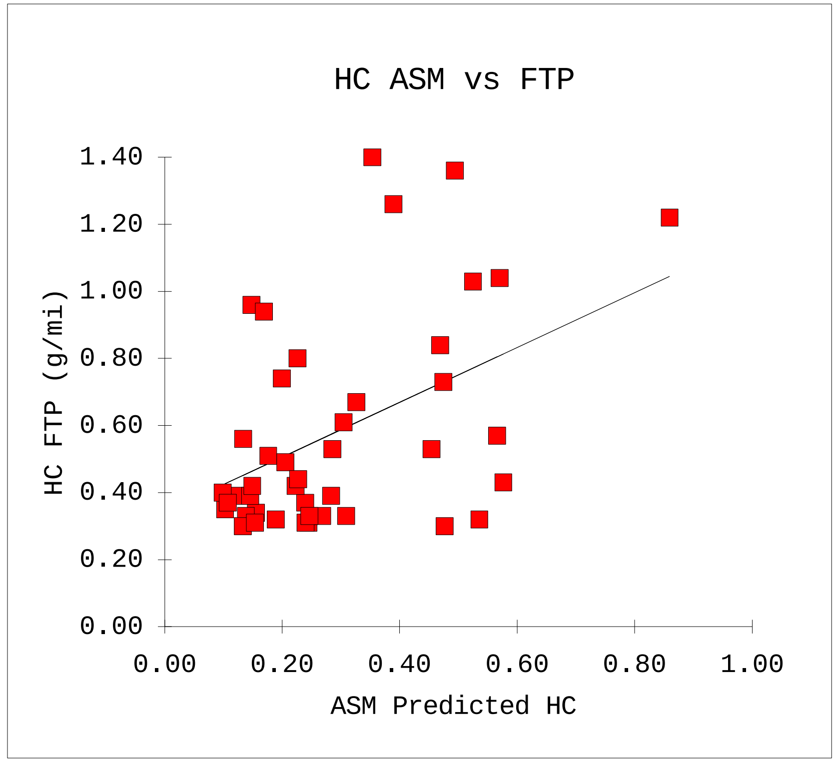
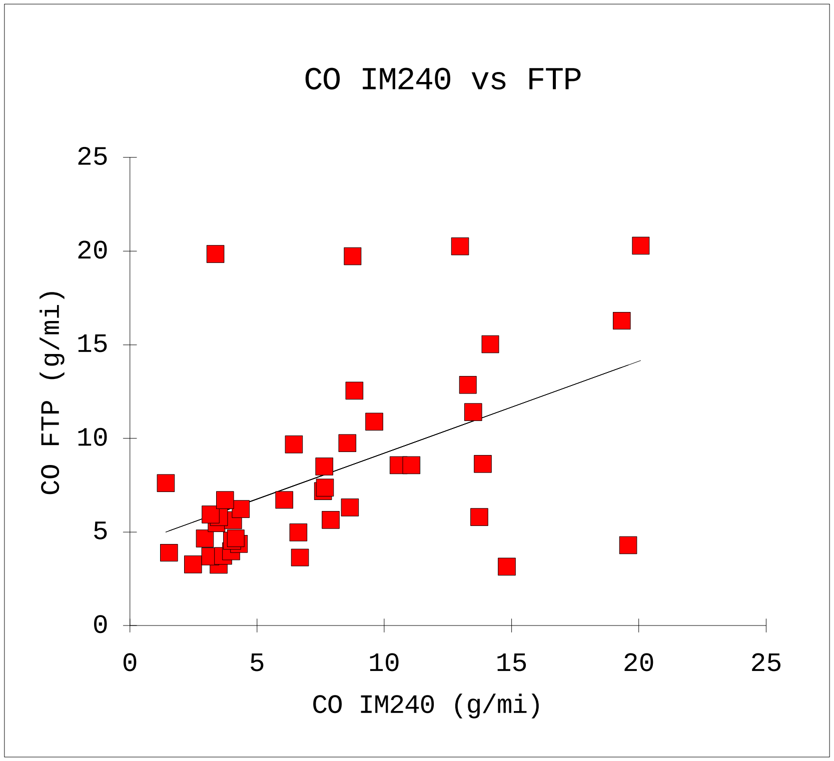


Figure F-8

CO Scatterplots

Vehicles Near Standards



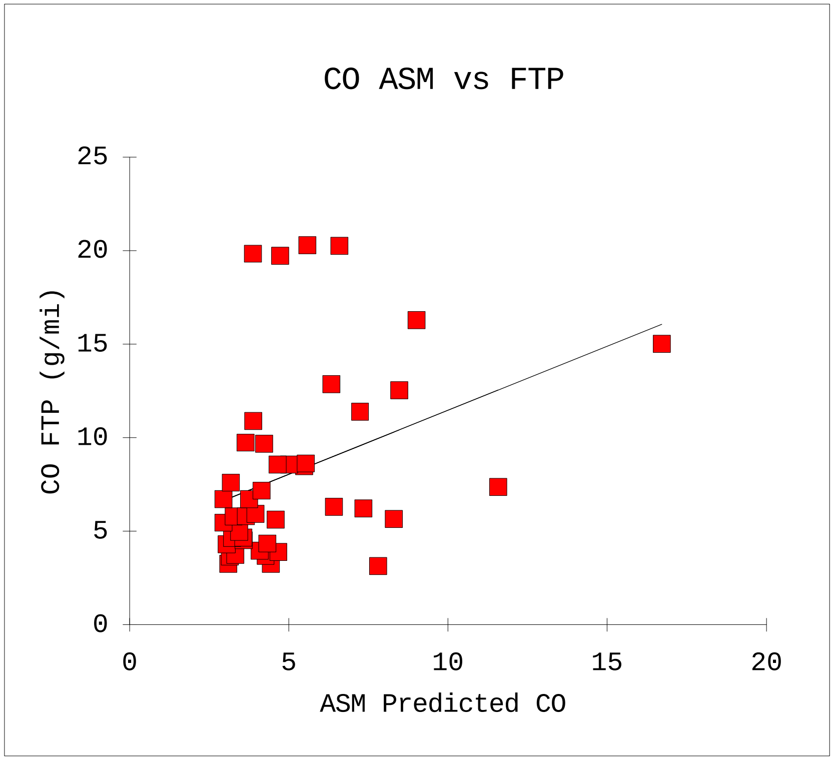
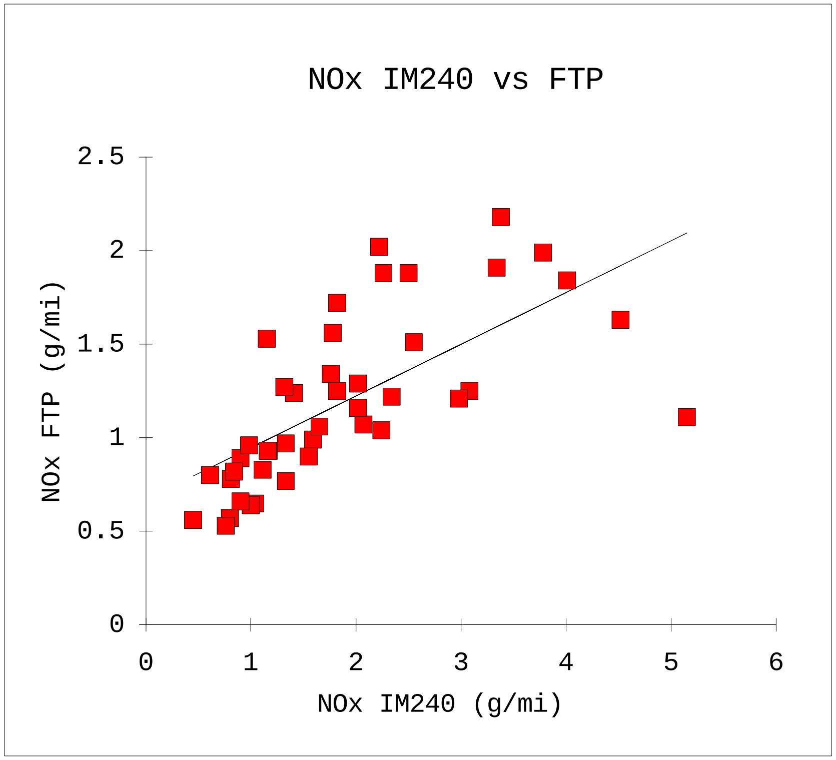
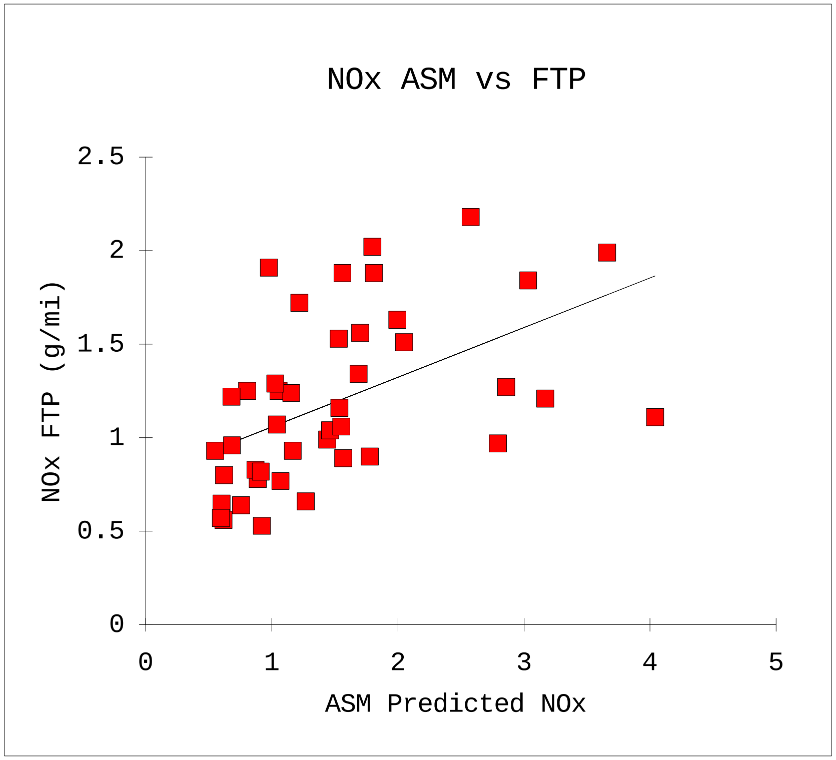


Figure F-9
NOx Scatterplots
Vehicles Near Standards





Appendix G:

ARCO, Sierra, Environment Canada Data Analysis

1.0 Introduction

The objective of this report is to respond to the pilot ASM test programs performed by Sierra Research, Inc., ARCO Products Company, and Environment Canada. Sierra and ARCO both previously published papers praising the capabilities of the ASM, and both concluded that some form of the ASM could replace the IM240 as an enhanced I/M test.

EPA has concluded that the ARCO and Sierra reports are incorrect in claiming the ASM as equal to the IM240. Based on a comparison with a similar database of IM240 vehicles, the ASM is inferior to the IM240 at identifying excess emissions without committing false failures. Moreover, a series of regressions were run for both the ASM and the IM240 versus the FTP. The scatterplots for these regressions, contained in the Appendix to this report, show significant variability for the ASM at predicting FTP values, compared to the IM240.

A contractor for EPA is currently testing a number of vehicles at a state I/M lane in Mesa, Arizona on both the IM240, and a 4 mode steady state test, which includes two ASMs, the ASM2525 and the ASM5015. A sample of vehicles is being recruited to the contractor's lab for further FTP testing. The data from that program will give EPA a chance to determine, with greater confidence, if some form of the ASM is as effective as the IM240.

This report focuses on a small dataset of vehicles, therefore the conclusions made in this report are subject to change when more data is available to EPA. However, from the data that has been presented to EPA to date on the ASMs, the IM240 remains the only enhanced I/M test.

2.0 Database Description

There are 31 vehicles in the ASM database EPA used for this analysis. The data were gathered from programs performed by three different organizations: Environment Canada [1], Sierra Research [2], and ARCO Products [3]. EPA started

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[1] Ballantyne, Vera F. Draft, Steady State Testing Report and Data, Environment Canada, August 28, 1992.

[2] Austin, Thomas C., Sherwood, Larry, Development of Improved Loaded-Mode Test Procedures for Inspection and Maintenance Programs, Sierra Research, Inc. and California Bureau of Automotive Repair, SAE Paper No. 891120, Government/Industry Meeting and Exposition, May 2-4, 1989.

performing ASM tests in Mesa Arizona on September 10, 1992. These data will be the topic of a separate analysis.

A number of vehicles in the ASM database were tested with and without implanted defects, so 51 test configurations were used for this analysis. All the vehicles tested by the three different organizations received the ASM5015 and the FTP, but ARCO did not perform the ASM2525. This left 39 test configurations receiving multiple-mode ASM tests and FTPs.

2.1 ASM Vehicles Removed from Database

There were originally 55 vehicles tested in the three programs, resulting in 117 test configurations, broken down as follows: Environment Canada (32 vehicles or 36 configurations); Sierra Research (18 vehicles or 51 configurations), and ARCO Products (5 vehicles or 30 configurations). Vehicles were removed from the database for reasons which are discussed below.

First, all pre-1983 vehicles were removed to focus on newer technology vehicles. So 3 Canadian vehicles and 5 Sierra vehicles were removed, leaving 29 Canadian vehicles with 33 configurations and 13 Sierra vehicles also with 33 configurations.

Next all pre-1988 Canadian vehicles were removed. Canadian vehicle standards were not lowered to 0.41/3.4/1.0 until the 1988 model year, so the prior model years could not be used. So 13 Canadian vehicles were removed, leaving 16 Canadian vehicles with 20 configurations.

Next, all ARCO vehicles that were not certified to the 50-state standards of 0.41/3.4/1.0 were removed. Three ARCO vehicles were certified to California-only standards, so they were removed, leaving 2 ARCO vehicles with 12 configurations.

Finally, all Sierra configurations that received hot-start FTPs instead of cold-start FTPs were removed. Because the normal cold-start FTP is more variable than hot-start FTPs, short test comparisons should be made using cold-start FTPs. Also, vehicles are certified using cold-start FTPs, so the results are more relevant. So 14 Sierra configurations were removed, leaving 13 Sierra vehicles with 19 configurations.

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[3] Boekhaus Kenneth L., et al. Evaluation of Enhanced Inspection Techniques on State-of-the-Art Automobiles. ARCO Products Company Report, May 8,1992.

2.2 Selection of IM240 Vehicles Used in Database

In order to compare the ASM to the IM240, the analysis should be performed on a set of vehicles that have received both tests. However, none of the ASM vehicles received the IM240, therefore 39 vehicles were randomly selected from the Indiana laboratory IM240 database. These vehicles were chosen from those used in the IM240 cutpoint table analysis in EPA's I/M Costs, Benefits, and Impacts Analysis, which included 274 vehicles with both IM240 and FTP results. In order to make the IM240 database similar to the ASM database, the following process was used.

First, the ASM vehicles were categorized by emission levels according to the following table:

Table 1. Number of Vehicles in Database per Emittant Category.

HC/CO Category	NOx Category	HC Range*	CO Range*	NOx Range	# in Dataset
Normal	Normal	$0^{2}HC<0.82$	$0^{2}CO<10.2$	$0^{2}NOx<2$	29
Normal	High	$0^{2}HC<0.82$	$0^{2}CO<10.2$	$2^{2}NOx<4$	1
High	Normal	$0.82^{2}HC<1.64$	$10.2^{2}CO<13.6$	$0^{2}NOx<2$	2
Very High	Normal	$1.64^{2}HC<10.0$	$13.6^{2}CO<150$	$0^{2}NOx<2$	4
Very High	High	$1.64^{2}HC<10.0$	$13.6^{2}CO<150$	$2^{2}NOx<4$	3

* These are the same categories as those used in the I/M Technical Support Document

Second, the Lab IM240 database was broken down into these same categories. All vehicles were 1983+ model years, and only vehicles that received the lab IM240 *after* the FTP were kept in the database. This kept the IM240 database as similar as possible to the ASM database. From the remaining vehicles, a random sample was chosen from each category so that both databases had the same number of vehicles in each category.

By selecting the same number of vehicles from each emittant range, it prevents one test from getting an unfair advantage in achieving identification rates. For example, if the IM240 database included considerably higher FTP scores, it would have identified much more excess emissions, thus making its Identification Rates (IDRs) higher.

3.0 Calculating ASM Mass Emissions

Sierra indicated (SAE Paper No. 891120) that calculated ASM mass emissions correlate better to the FTP than concentration measurements, so their method of converting ASM NOx concentration measurements to "mass" emissions was applied to this ASM database for HC and CO, as well as NOx. This was done by multiplying the emission concentrations (ppm for HC and NOx, and % for CO) by the vehicles' Inertia Weights (IW), yielding the following units: kiloton-ppm for HC (IW * ppm/10^3), ton-% for CO (IW * %), and megaton-ppm for NOx (IW * ppm/10^6). These are the values EPA used for the regressions in this report.

3.1 EPA Equations Versus Sierra Equations

In their test program, Sierra measured the ASM emissions on both a concentration basis and mass basis. This allowed them to regress Concentration * Inertia Weight (IW) versus mass emissions for the same test, and develop equations that convert [Concentration * IW] to Mass. As expected, these mass calculations correlated very well with the measured mass emissions.

Sierra's next step was to regress the *measured* steady state mass emissions against the FTP emissions and report r^2s for these regressions. They did not actually use the calculated mass emissions to predict FTP scores. This is where EPA's analysis of the ASMs was slightly different. EPA regressed the [Concentration * IW] values against the FTP emissions for each vehicle. This was done because EPA did not have measured mass emissions from all three test programs compiled in this report. However, the major benefit of the ASMs, according to Sierra and ARCO, is the ability to use the less expensive BAR90 type analyzers when measuring the exhaust concentrations. Since this is a claimed benefit of the ASMs, the readings from these less expensive analyzers should be used when comparing the ASM to the IM240.

4.0 Multiple Linear Regressions for the ASM

Using data from all three previously mentioned programs, EPA calculated the IW * Concentration for each emittant. Then a multiple linear regression was performed, using the calculated (IW*Concentration) ASM2525 and ASM5015 scores as two separate variables vs measured FTP emissions. Equations were developed from these regressions that predict an FTP score from a combination of the ASM2525 and ASM5015 concentrations * IW scores:

Table 2. Equations Developed to Predict FTP from ASM Modes.

Predicted FTP = [IW (**A***ASM2525 + **B***ASM5015) + **C**]

Emittant	**A**	**B**	**C**	**r2**
HC (ppm)	-3.96×10^{-7}	4.60×10^{-7}	0.523520	49.2%
CO (%)	2.64×10^{-3}	5.10×10^{-5}	4.222840	43.5%
NOx (ppm)	1.13×10^{-7}	1.30×10^{-7}	0.515531	71.4%

4.1 Simple Linear Regressions

Aside from those already mentioned, regressions were also run for each individual ASM mode vs the FTP, and for the IM240 vs the FTP. Since the IM240 is a transient test, like the FTP, it correlates much better to the FTP than the ASM modes.

4.1.1 Coefficient of Determination (r^2)

The r^2 may be interpreted as the proportion of the total FTP variability that was predicted by the short test. For example, if the r^2 equalled 100%, the short test would have perfectly predicted the FTP scores for these cars. If the r^2 for these vehicles was zero, the short test would not have any linear relationship to the FTP.

The r^2 data, listed in table below, show that the IM240 is considerably better than the ASM tests in predicting FTP HC, CO, and NOx scores. For HC and CO, less than half of the FTP variation is explained by the ASM scores.

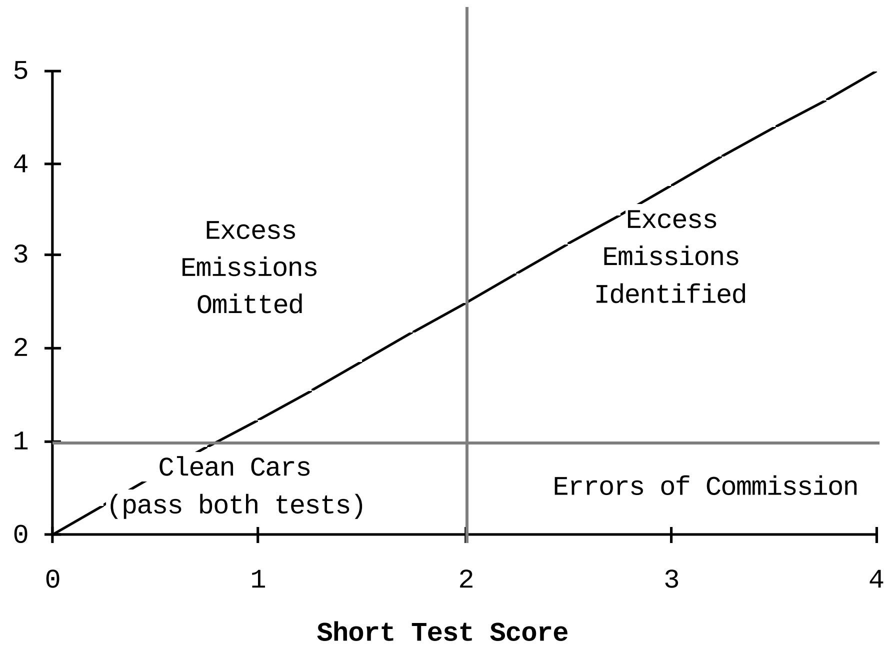
Table 3. Statistical Comparison of the FTP Versus I/M Tests

	HC			**CO**			**NOx**		
	IM240	**5015**	**2525**	**IM240**	**5015**	**2525**	**IM240**	**5015**	**2525**
r^2	95%	36%	20%	92%	45%	44%	84%	62%	70%

4.2 Scatterplots

For an I/M test, more important than the r^2 is the ability to identify high proportions of dirty cars without falsely failing vehicles. The IM240 also has a significant advantage at identifying more of the dirty cars while failing less of the clean cars. The scatterplots in the appendix show this clearly. When viewing the plots, consider the following chart for a reference.

Figure 1. Sample Scatterplot Used to Define Terms



The short test cutpoint under consideration is the vertical line, and the FTP standard is the horizontal line. The intersection of these lines splits the chart into quadrants. The goal of the short test is to maximize the number of FTP failing vehicles into the upper right quadrant, while minimizing the false failures in the lower right quadrant.

The more vehicles that appear in the upper left quadrant, the less effective the test becomes, because these are all dirty cars that are not identified by the short test. From this perspective, the advantages of the IM240 is clear. Every IM240 chart shows that an x-axis value (cutpoint) can be selected that clearly places the vast majority of dirty cars in the upper-right quadrant, without errors of commission. The ASM tests do not display this trait nearly as well. Only the 2-mode ASM tests and the IM240 scatterplots have the horizontal and vertical lines on them, so the reader can examine different cutpoint scenarios.

4.2.1 Scatterplot Statistics

Each of the regression scatterplots contains the following information:

- The best-fit regression line showing predicted FTP for a continuum of short test scores, developed from a regression of the actual data.
- ‘Boundary Lines’ at + 2 and - 2 standard error from the predicted value.
- A horizontal dotted line at the FTP standard.
- A box containing descriptive statistics.

On each Regression plot, a box in the upper-left corner provides the following statistics: 1) The equation of the line used to predict FTP values from the short test’s score. 2) r^2, discussed above. 3) The standard error *, a statistic that describes the variability of the FTP score predicted from the selected short test. The next section discusses standard error in more detail.

4.3 Standard Error as a Measure of Variability

The weakness of the ASM tests regarding r^2 and the low proportion of cars that can be identified as dirty while simultaneously avoiding false failures, is related to test variability. The standard error is an objective measurement of test variability. The following shows that the ASM tests are significantly more variable than the IM240, using the standard error as an objective measure of variability.

4.3.1 Assumptions Made for Using Standard Error

The following assumptions were made in order to use standard error as it is used in this report:

- Linear relationship between the FTP and the short tests.

- Normally distributed data.

- Homoscedastic distribution (i.e., the standard deviation of FTP values is constant for all short test values).

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* What is referred to in this report is formally termed standard error of estimate, but for convenience purposes, will simply be called standard error.

The standard error is similar to standard deviation because a bandwidth of ±1 std. error includes Å68% of the data and ±2 std. error includes Å95% of the data.

4.3.2 Example Using Standard Error

Consider a 3000 lb. vehicle that emits 1500 ppm NOx on both the ASM5015 and ASM2525. Plugging these numbers into the equation for predicting FTP values (Table 2) yields 1.61 g/mi. However, because the standard error for ASM NOx (see Table 4) is 0.36 g/mile, roughly 5% of the FTP scores predicted by the ASM result will be greater than 2.33 g/mile (1.61 + 2*0.36) or less than 0.89 g/mile (1.61 - 2*0.36). Since half of these will err on the low side, it is probable that Å2.5% of the vehicles identified as failures by an ASM cutpoint of 1.61 g/mi would be false failures.

4.3.3 Effect of Standard Error on "Safe FTP Predictions"

In order to be confident the false failure rate would be less than 2.5% the selected cutpoint should predict an FTP value of 2 standard errors greater than the FTP standard. This ensures that the low values (FTP prediction - 2 std. error) are still failing the FTP.

For example,

FTP NOx standard is 1.0 g/mi
The ASM NOx std. e rror is 0.36 g/mi
$FTP_{standard}$ + 2 std. errors = 1.72 g/mi

So, the selected ASM cutpoint should predict an FTP of no less than 1.72 g/mi. Applying the same logic to the IM240, whose standard error is 0.28 g/mi, a predicted FTP score of 1.56 g/mi (1.0 + 2*0.28) will also yield an error of commission rate less than 2.5%. But because the “safe” predicted FTP score is more stringent, the excess emissions identified will be higher. The standard errors and predicted FTP levels that are expected to limit false failures to approximately 2.5% are compared in Table 4 below.

Table 4. Comparison of ASM and IM240 Standard errors And Their Effect on Predicted FTP Stringency at a 2.5% False Failure Rate

	HC		CO		NOx	
	IM240	**ASM**	**IM240**	**ASM**	**IM240**	**ASM**
1 std. error (g/mi)	0.24	0.60	3.8	4.8	0.28	0.36
Predicted FTP Level @ Å2.5% Ec (g/ mi)	0.89	1.61	11.0	13.0	1.56	1.72

5.0 Cutpoint Tables

Another way to assess the effectiveness of I/M tests is to evaluate the following factors, which were discussed in detail in Section 4.2.1 of EPA's I/M Costs, Benefits, and Impacts Analysis: excess emission identification rates, failure rates, error-of-commission rate, the failure rate among vehicles that pass FTP standards, and the failure rate for so-called "normal emitters," which may fail an FTP standard (normal emitters are defined as vehicles whose FTP HC < 0.82 g/mi and FTP CO < 10.2 g/mi), but are clean enough to make the cost effectiveness of repairs an issue. These factors are highly interactive, for example, high IDRs can be achieved with stringent cutpoints, but this will adversely affect failure rates.

Cutpoint tables for the ASM tests and the IM240 in the appendix allow these factors to be compared. The cutpoints for the tables were chosen using an iterative process. The goal was to select cutpoints that would give reasonable identification rates while limiting errors of commission. The goal was to keep the Ec rate at 0% for both procedures.

For both cutpoint tables, four different cutpoints were selected for each of the three emittants, resulting in 64 different cutpoint combinations. For the IM240, the "Two Ways to Pass Criteria" was used, as described in Section 4.2.3.2 of EPA's I/M Costs, Benefits, and Impacts Analysis. This is a method of combining the composite HC and CO scores with the bag 2 HC and CO scores in order to minimize Errors of Commission on vehicles with cold start problems, while maintaining high Identification Rates.

5.1 Selecting ASM Cutpoints

Scatterplots were done plotting Measured FTP vs. Calculated FTP from the ASM scores. From these scatterplots, EPA determined a range of cutpoints to use for the cutpoint tables. For example, looking at Chart x, FTP CO vs ASM

Prediction CO, it can be determined that an ASM Prediction between 6 and 10 grams/mile would identify most dirty vehicles (those above the standard of 3.4 g/mi) without failing the clean vehicles. It is also obvious that a cutpoint of 5 would falsely fail at least one vehicle while achieving no added benefit. Consequently, the chosen CO cutpoints for the ASM range from 6 to 20. The range of cutpoints for HC and NOx were chosen the same way.

5.1.1 Using Standard error to Predict Reasonable Cutpoints

Although the cutpoint tables do include a wide range of cutpoints, there is still a concern that the errors of commission are not representative of what they might be in a real world scenario. For this reason, the cutpoints shaded at the end of each table were selected using the standard error.

The ASM cutpoints used are identical to the "safe FTP predictions" in Table 4. This is because the values are obtained from calculations using both ASM scores. Each mode has a "sliding scale" of cutpoints, dependent on the other mode results. In other words, no single ASM5015 or ASM2525 value can be used for a cutpoint since a vehicle might be clean on one mode and very dirty on the other. The cutpoints for the IM240, on the other hand, are direct IM240 scores, in grams per mile. The "safe cutpoints" for the IM240 were determined by calculating the IM240 score that would predict the "safe FTP Level Å 2.5% Ec" (see Table 4), using the equations on each respective IM240 scatterplot.

For example, the IM240 HC FTP Level Å 2.5% Ec is 0.89 g/mi. The regression equation on the IM240 vs FTP scatterplot is:

$$FTP_{pred.} = 1.429 * IM240 + 0.04;$$

Since we want to predict an FTP of no less than 0.89 g/mi, setting $FTP_{pred.}$ equal to 0.89 yields an IM240 score of 0.60 g/mi. This was done to calculate each "safe cutpoint" for the IM240.

5.2 Limitations of Cutpoint Tables

It is important to recognize several limitations in these tables. Most important is that the database is very small and does not represent the in use fleet. Additionally, the vehicles were preconditioned by the FTP before the ASM test and before the IM240 tests, so the correlation between these short tests will be much better than can be expected for vehicles tested in an I/M lane, because of all the uncontrolled variables associated with I/M lane tests like temperature, fuel RVP, distance driven prior to the test, catalyst temperature, etc. Because all of these variables were controlled for the vehicles in the ASM and IM240 databases, the cutpoints can be very stringent while still avoiding false failures. For example, the IM240 table shows that cutpoints of 0.4/6/1.0 yield IDRs of 97%, 93%, and 100%, for HC, CO and NOx, respectively, without errors of commission. If cutpoints this stringent were used for random vehicles tested in I/M lanes, the error of commission rate would be unacceptably high. Similarly, because of the introduced malfunctions, the failure rates are not representative of the in-use fleet failure rates for an acceptable I/M program. So, while it is valid to use these cutpoint tables to compare the ASM to the IM240, it is not valid to assume that the rates are representative of those that will be realized in a real I/M program. The ASM and IM240 testing that EPA is currently sponsoring in Mesa will provide the actual in-use fleet rates.

5.3 IM240 Identifies Much More Excess Emissions

Using the cutpoint tables to compare the two procedures, the IM240 did considerably better than the Two-Mode ASM at each tests' optimal cutpoints [*]. The IM240 identified 97% of excess HC, 93% of excess CO, and 100% of excess NOx at cutpoints of 0.4/6/1.0 (HC/CO/NOx). The Two-Mode ASM identified 87%, 80%, and 75% of HC, CO, and NOx, respectively at cutpoints of 0.6/6/1.50.

As discussed in the Variability section, using the standard error of estimate to choose cutpoints that should prevent exceeding an error of commission rate of 2.5% can help in assessing the performance of I/M tests. The shaded cutpoints at the end of each test’s cutpoint table suggest that the IM240's performance is significantly better than the two-mode ASMs. Using the “safe” cutpoints, the IM240 identifies 92%, 84%, and 71% excess of the excess HC, CO, and NOx, respectively - the Two-Mode ASM only identifies 75%, 63%, and 64%.

6.0 <u>Summary</u>

The ASM tests were considerably more variable than the IM240 under controlled laboratory conditions, as evidenced by subjective analyses of the scatter plots and objective measurements using the standard error statistic. Testing at real-world I/M lanes will add considerably more variability to both tests, because conditions known to affect emissions such as temperature, humidity, and vehicle operating conditions prior to the test. These uncontrolled variables are expected to add proportionally more variability to a steady state test like the ASM, but data are not available to evaluate the validity of the hypothesis.

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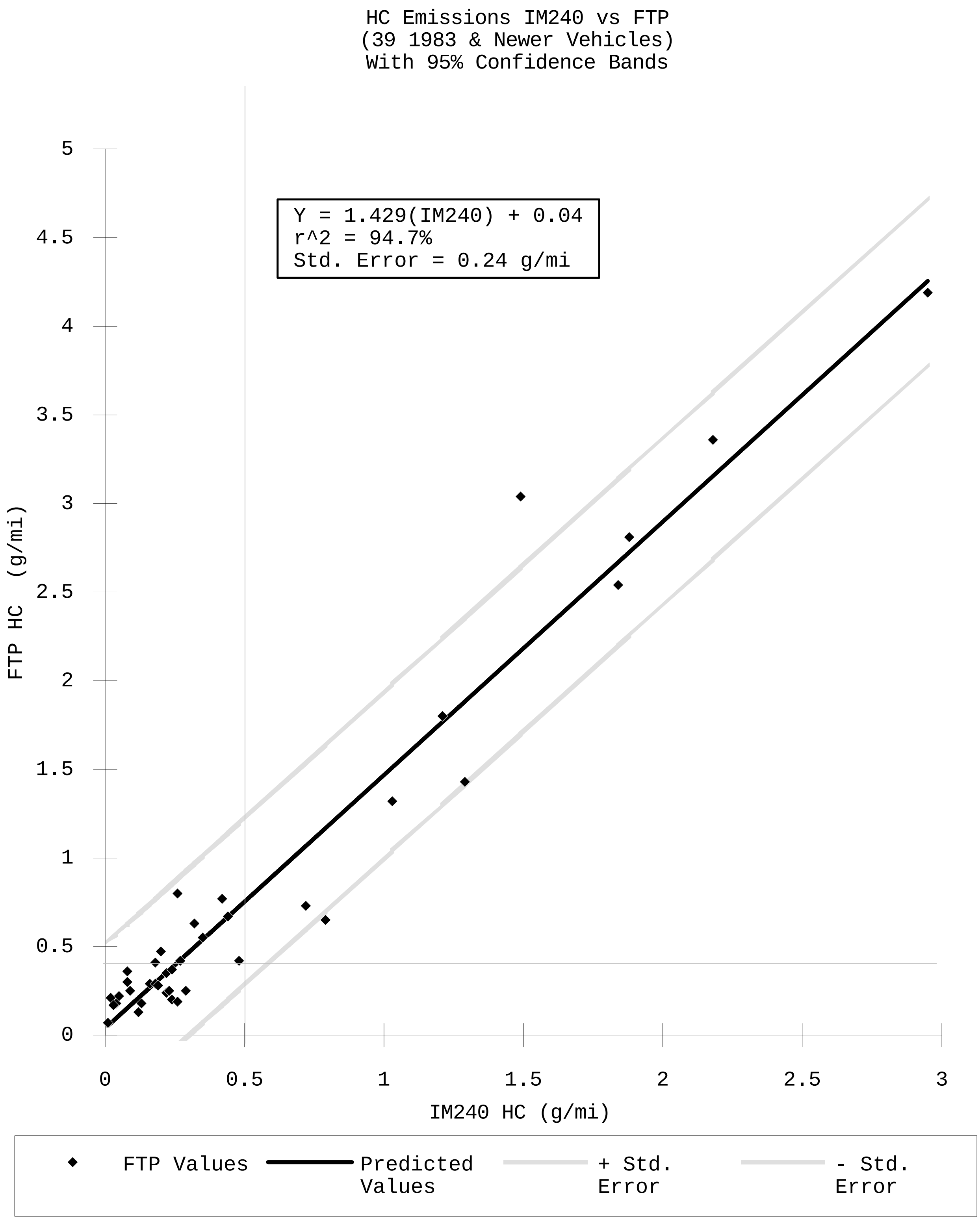
[*] 'Optimal Cutpoints', as used here, is the lowest cutpoints the test could go to and still have zero errors of commission.

On the other hand, the increased variability associated with actual I/M testing will be somewhat offset for the ASM by adding two additional modes; a 50 mph steady mode at road-load horsepower, and an idle mode. This four-mode ASM procedure is now being performed by EPA in a Mesa Arizona I/M lane.

The result of these offsetting effects on variability will determine the viability of the ASM as a lower cost substitute for the IM240. A final conclusion should be postponed until enough Mesa data can gathered for a valid evaluation.

Figure B-1



HC Emissions IM240 vs FTP
(39 1983 & Newer Vehicles)
With 95% Confidence Bands
Y = 1.429(IM240) + 0.04
r^2 = 94.7%
Std. Error = 0.24 g/mi
FTP HC (g/mi)
IM240 HC (g/mi)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
FTP Values
Predicted Values
+ Std. Error
- Std. Error

Figure B-2

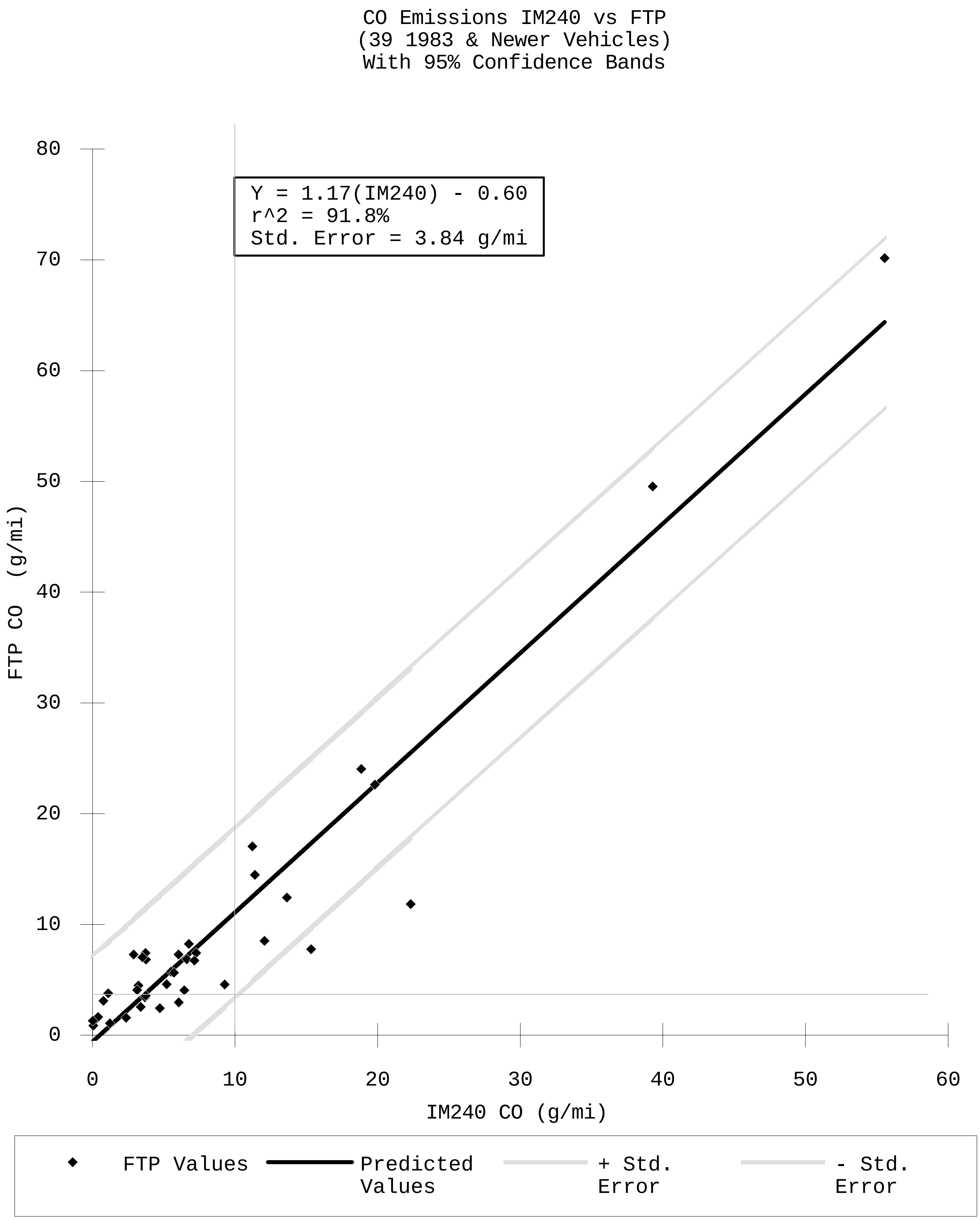
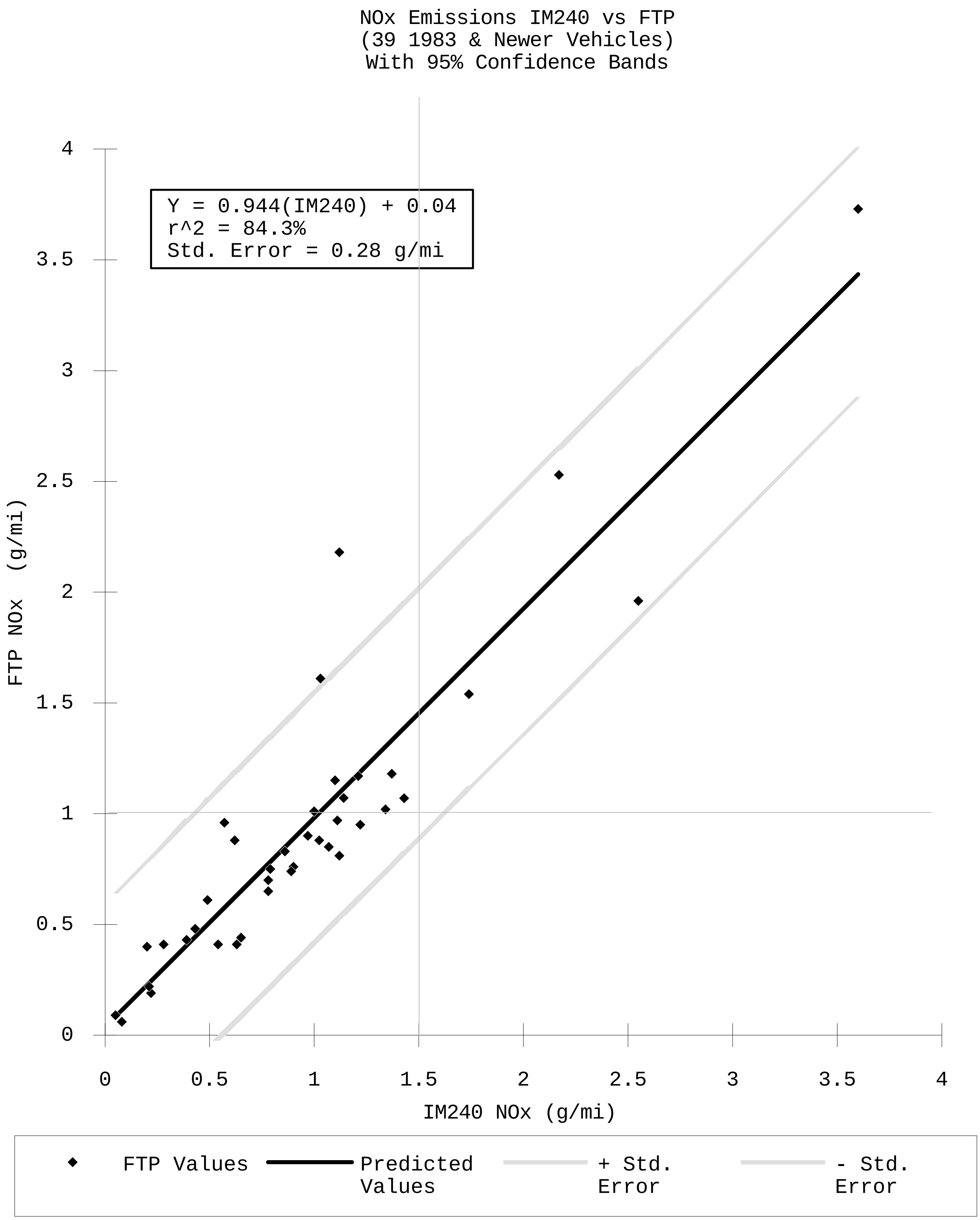
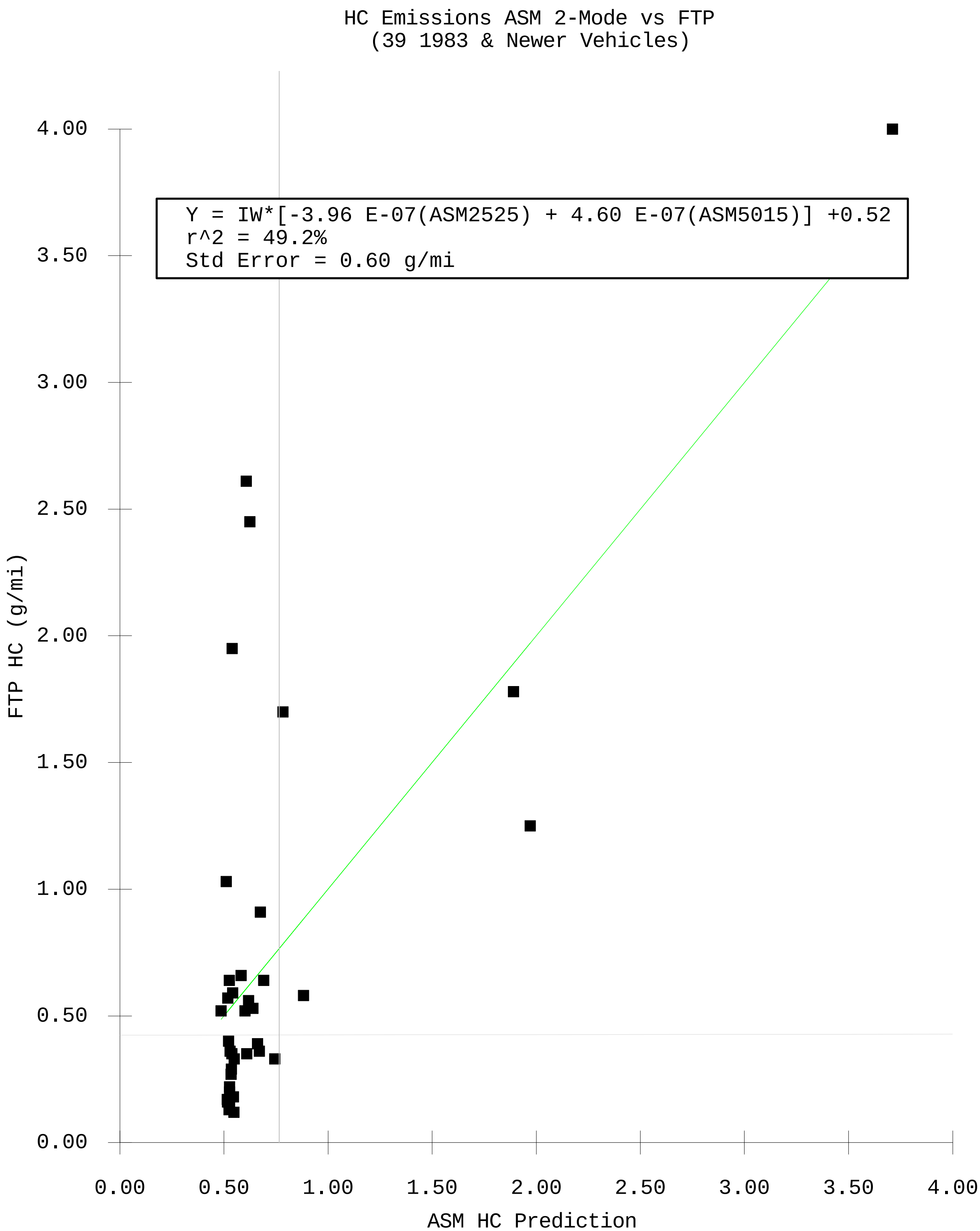

CO Emissions IM240 vs FTP
(39 1983 & Newer Vehicles)
With 95% Confidence Bands
Y = 1.17(IM240) - 0.60
r^2 = 91.8%
Std. Error = 3.84 g/mi
80
70
60
50
40
30
20
10
0
FTP CO (g/mi)
0
10
20
30
40
50
60
IM240 CO (g/mi)
FTP Values
Predicted Values
+ Std. Error
- Std. Error

Figure B-3



NOx Emissions IM240 vs FTP
(39 1983 & Newer Vehicles)
With 95% Confidence Bands
Y = 0.944(IM240) + 0.04
r^2 = 84.3%
Std. Error = 0.28 g/mi
FTP NOx (g/mi)
IM240 NOx (g/mi)
0
0.5
1
1.5
2
2.5
3
3.5
4
FTP Values
Predicted Values
+ Std. Error
- Std. Error

Figure B-4



HC Emissions ASM 2-Mode vs FTP
(39 1983 & Newer Vehicles)
Y = IW*[-3.96 E-07(ASM2525) + 4.60 E-07(ASM5015)] +0.52
r^2 = 49.2%
Std Error = 0.60 g/mi
FTP HC (g/mi)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
ASM HC Prediction

Figure B-5

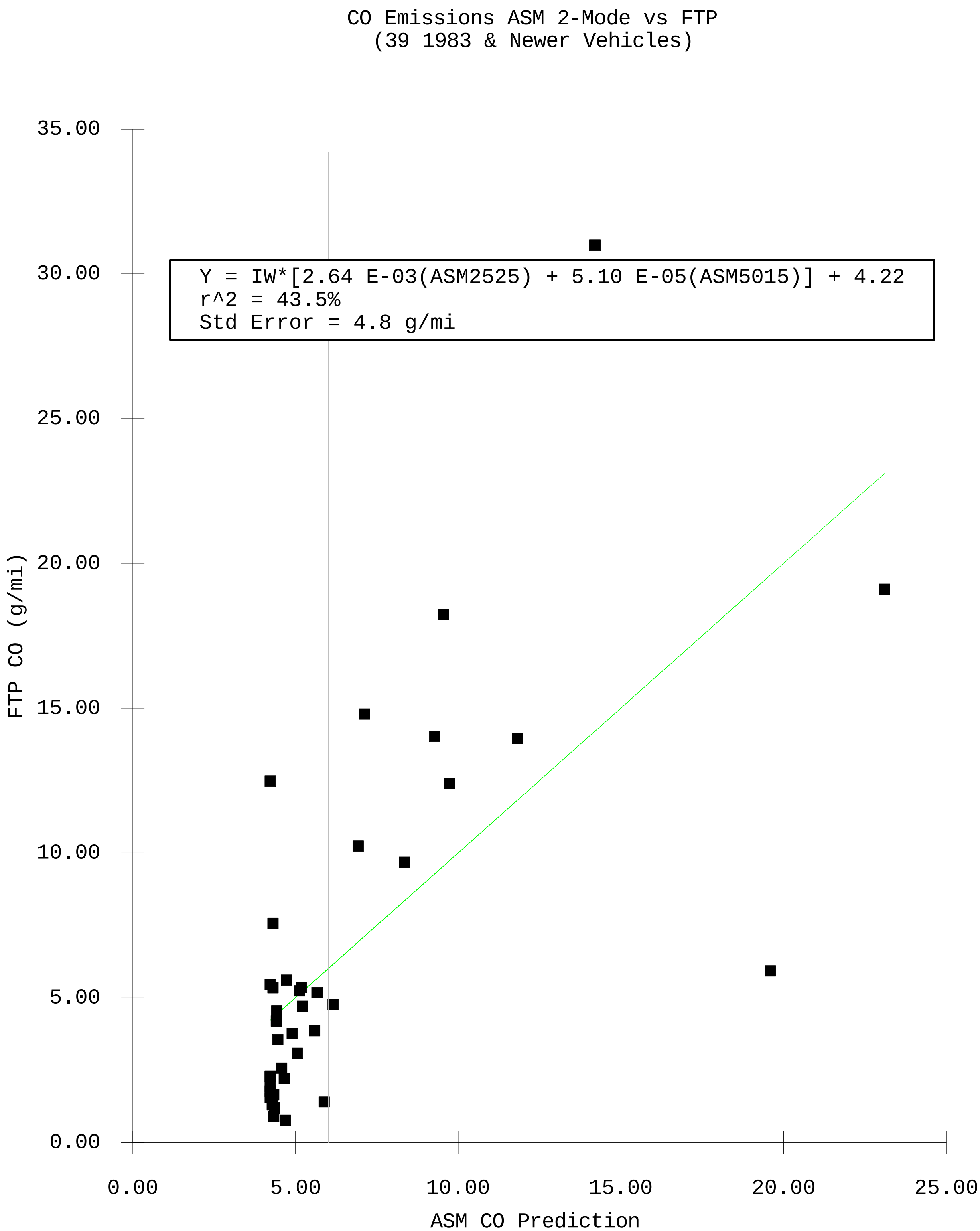

CO Emissions ASM 2-Mode vs FTP
(39 1983 & Newer Vehicles)
Y = IW*[2.64 E-03(ASM2525) + 5.10 E-05(ASM5015)] + 4.22
r^2 = 43.5%
Std Error = 4.8 g/mi
FTP CO (g/mi)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
ASM CO Prediction

Figure B-6

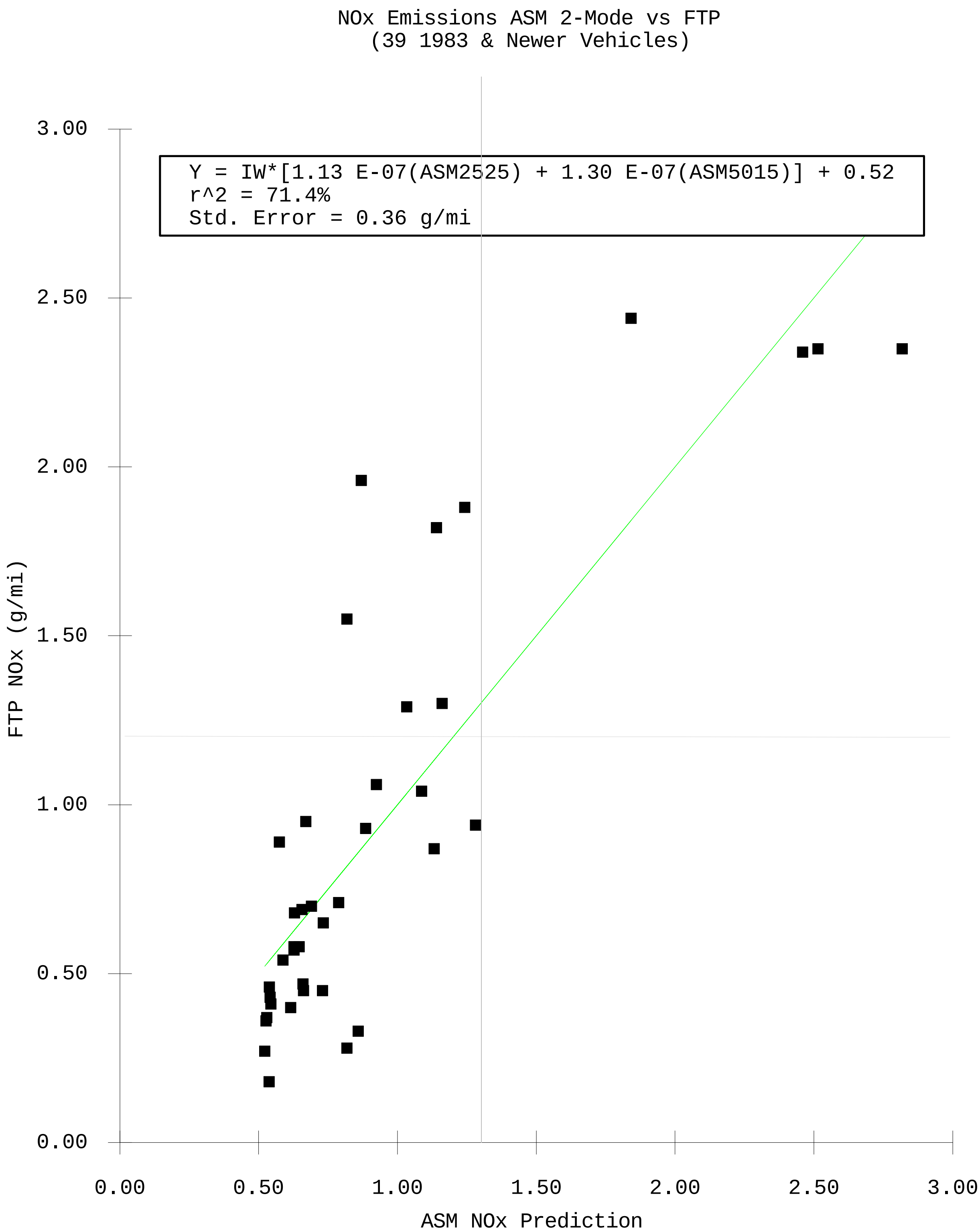

NOx Emissions ASM 2-Mode vs FTP
(39 1983 & Newer Vehicles)
Y = IW*[1.13 E-07(ASM2525) + 1.30 E-07(ASM5015)] + 0.52
r^2 = 71.4%
Std. Error = 0.36 g/mi
FTP NOx (g/mi)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
ASM NOx Prediction

Figure B-7

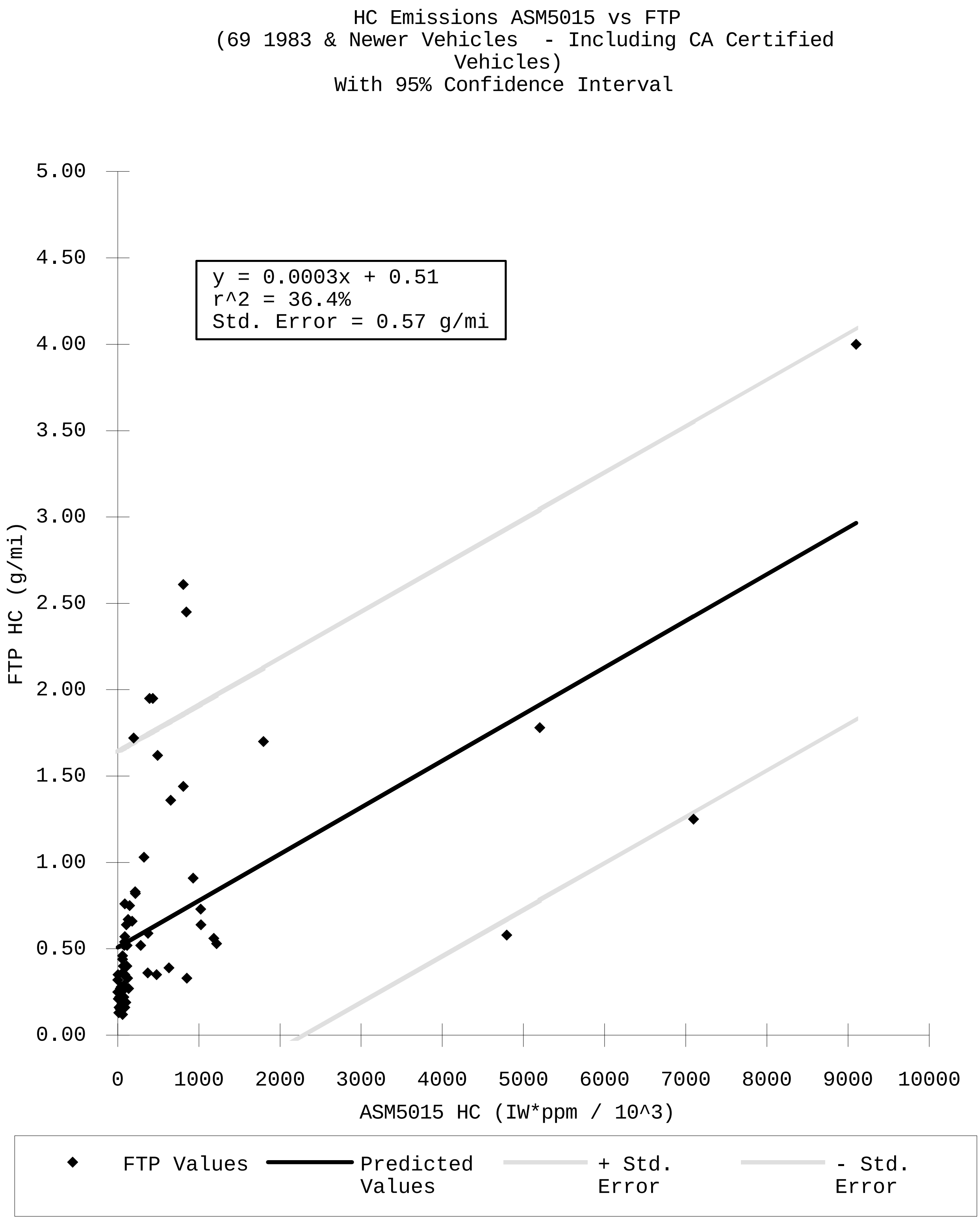

HC Emissions ASM5015 vs FTP
(69 1983 & Newer Vehicles - Including CA Certified Vehicles)
With 95% Confidence Interval
y = 0.0003x + 0.51
r^2 = 36.4%
Std. Error = 0.57 g/mi
FTP HC (g/mi)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
ASM5015 HC (IW*ppm / 10^3)
FTP Values
Predicted Values
+ Std. Error
- Std. Error

Figure B-8

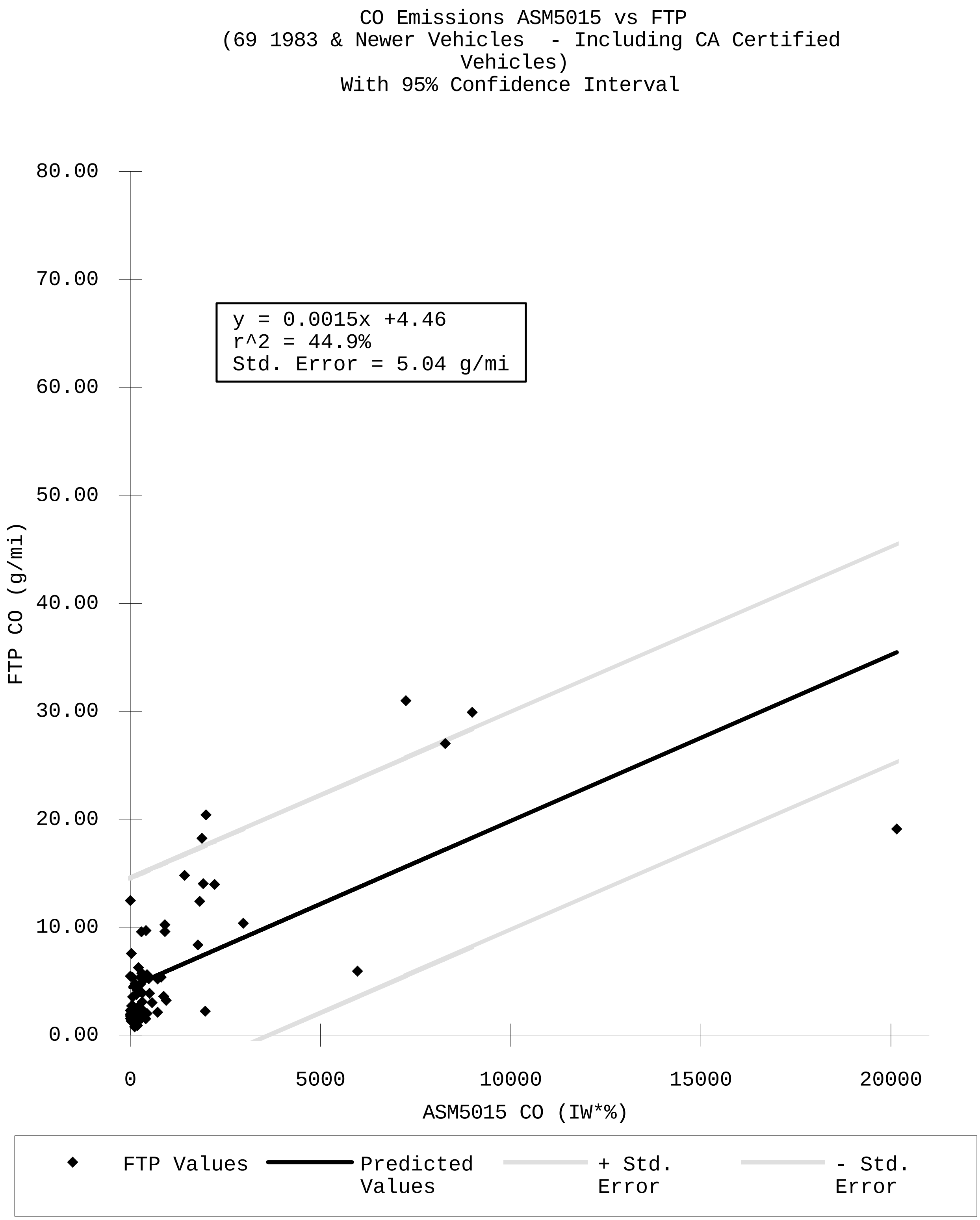
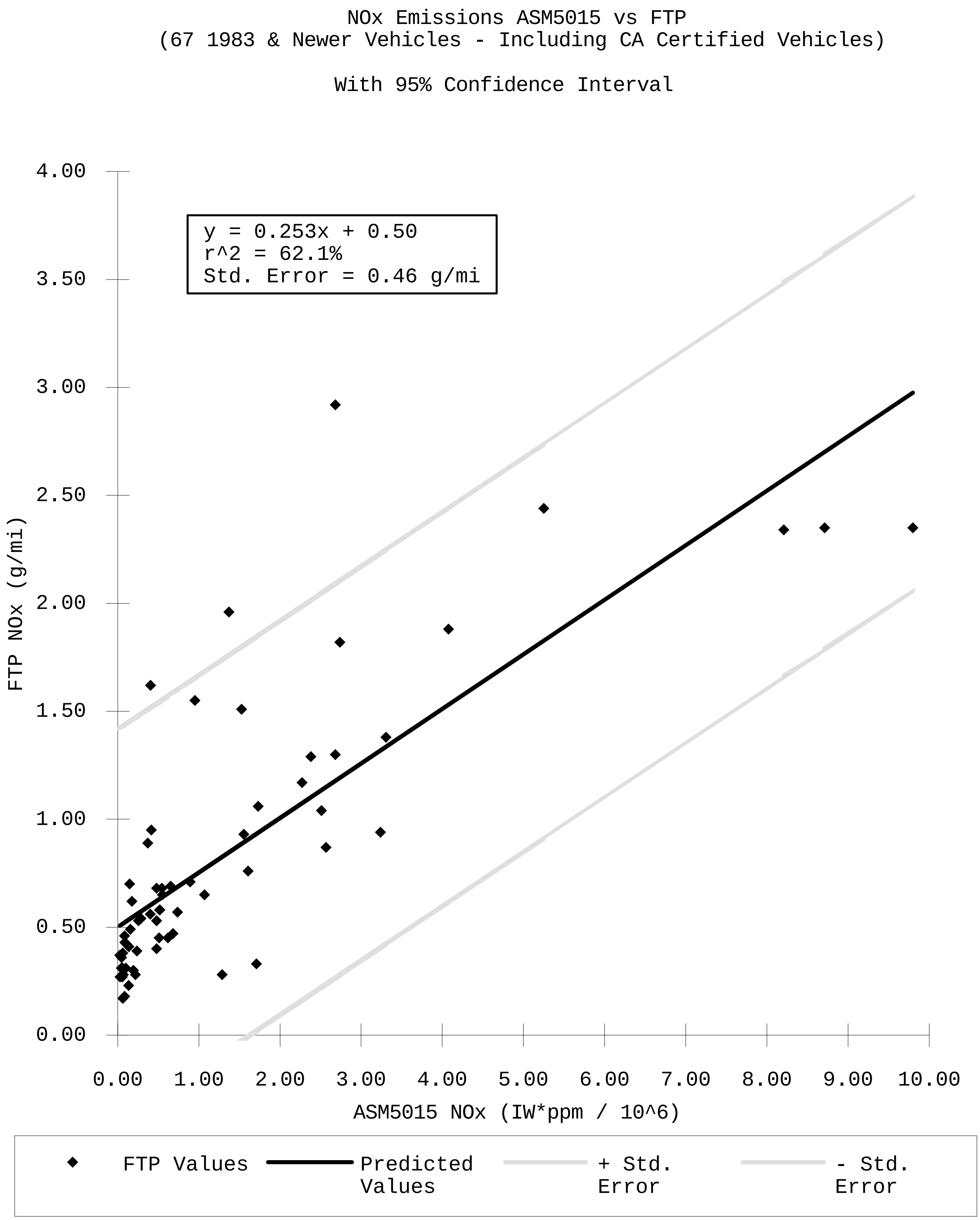

CO Emissions ASM5015 vs FTP
(69 1983 & Newer Vehicles - Including CA Certified Vehicles)
With 95% Confidence Interval
y = 0.0015x +4.46
r^2 = 44.9%
Std. Error = 5.04 g/mi
FTP CO (g/mi)
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
5000
10000
15000
20000
ASM5015 CO (IW*%)
FTP Values
Predicted Values
+ Std. Error
- Std. Error

Figure B-9



NOx Emissions ASM5015 vs FTP
(67 1983 & Newer Vehicles - Including CA Certified Vehicles)
With 95% Confidence Interval
y = 0.253x + 0.50
r^2 = 62.1%
Std. Error = 0.46 g/mi
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
FTP NOx (g/mi)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
ASM5015 NOx (IW*ppm / 10^6)
FTP Values
Predicted Values
+ Std. Error
- Std. Error

Figure B-10

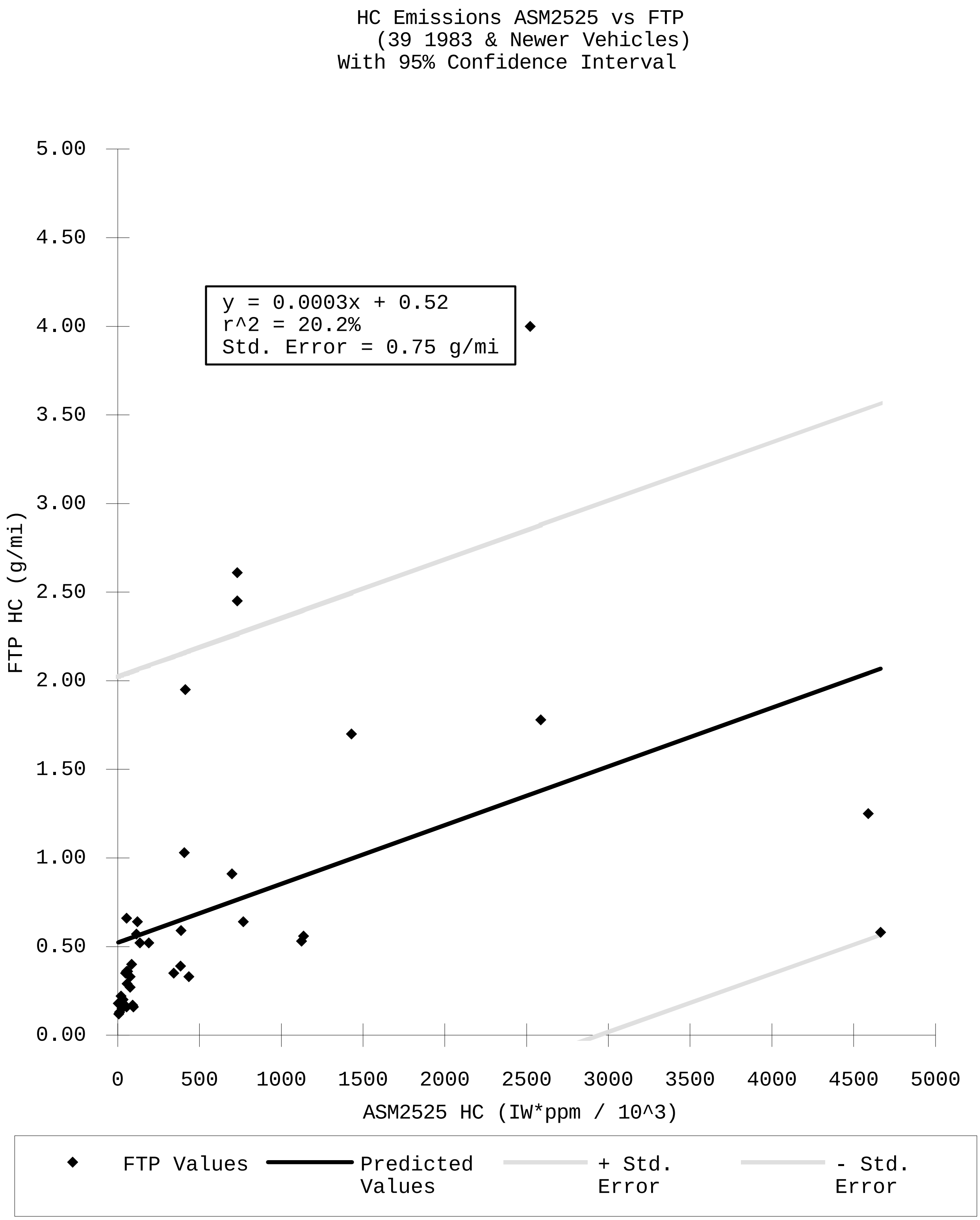

HC Emissions ASM2525 vs FTP
(39 1983 & Newer Vehicles)
With 95% Confidence Interval
y = 0.0003x + 0.52
r^2 = 20.2%
Std. Error = 0.75 g/mi
FTP HC (g/mi)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
ASM2525 HC (IW*ppm / 10^3)
FTP Values
Predicted Values
+ Std. Error
- Std. Error

Figure B-11

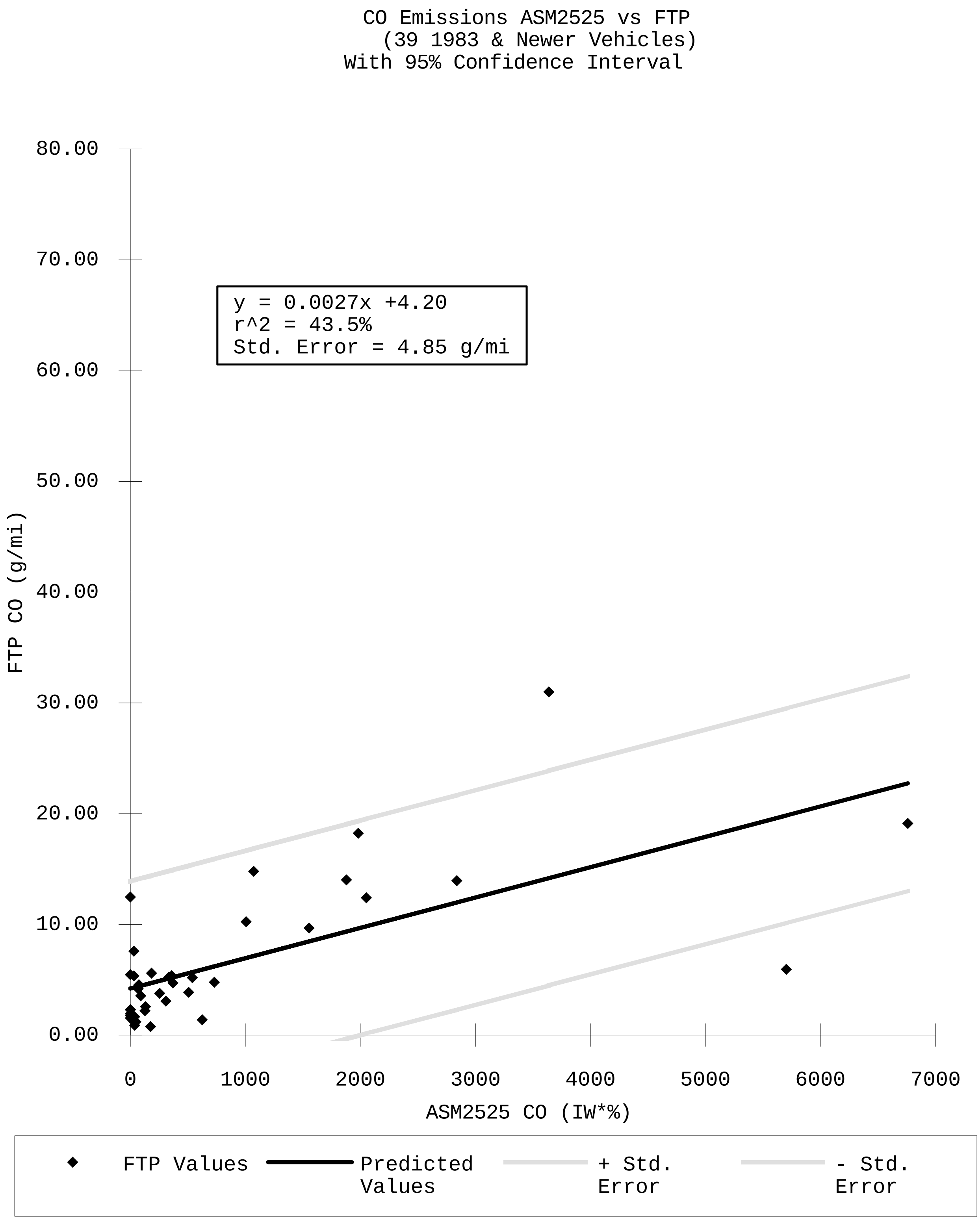
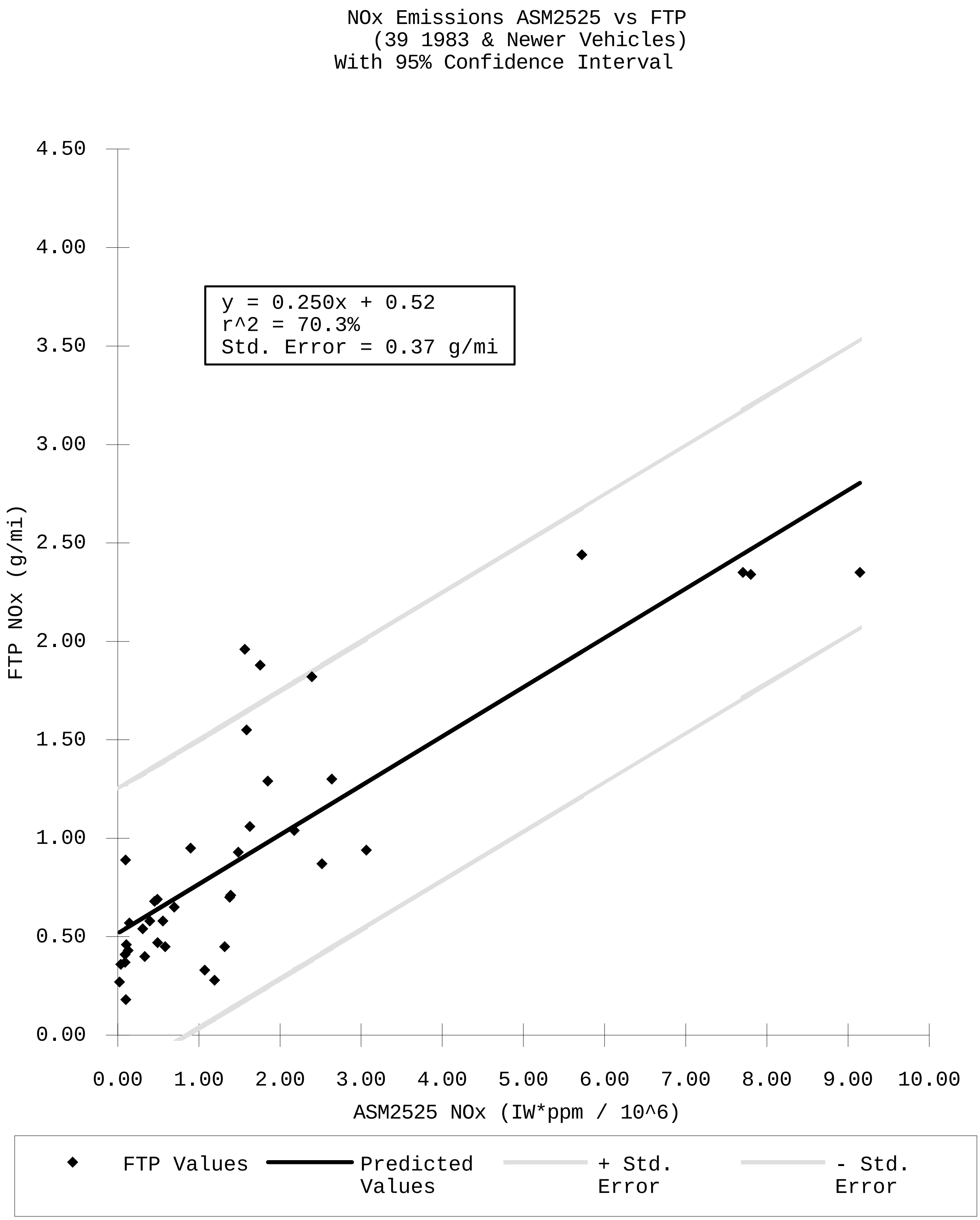

CO Emissions ASM2525 vs FTP
(39 1983 & Newer Vehicles)
With 95% Confidence Interval
y = 0.0027x +4.20
r^2 = 43.5%
Std. Error = 4.85 g/mi
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
FTP CO (g/mi)
0
1000
2000
3000
4000
5000
6000
7000
ASM2525 CO (IW*%)
FTP Values
Predicted Values
+ Std. Error
- Std. Error

Figure B-12



NOx Emissions ASM2525 vs FTP
(39 1983 & Newer Vehicles)
With 95% Confidence Interval
y = 0.250x + 0.52
r^2 = 70.3%
Std. Error = 0.37 g/mi
FTP NOx (g/mi)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
ASM2525 NOx (IW*ppm / 10^6)
FTP Values
Predicted Values
+ Std. Error
- Std. Error

Appendix H:

Estimated Cost of High-Tech I/M Testing

5.2.1 General Methodology

EPA's estimates of the costs of high-tech test procedures are driven by a number of assumptions. Costs in conventional centralized and decentralized test-and-repair programs were derived using current inspection costs in I/M programs as they are reported to EPA as the starting point. For decentralized test-only networks costs are modelled in a manner similar to centralized programs, since all current test-only programs are centralized, however, costs are estimated using a range of test volumes and a higher level of state oversight is assumed since the network is composed of independent operators and may have a higher number of test sites than in centralized programs.

Another key assumption is that adding the new tests will increase inspection costs in programs that are now efficiently designed and operated. In programs that are not now well designed, current costs are likely to be higher than necessary and the cost increase less if efficiency improvements are made simultaneously. In order to perform the high-tech tests new equipment will have to be acquired and additional inspector time will be required for some test procedures. The amount of the cost increase will be determined to a large degree by the costs of acquiring new equipment and the impact of the longer test on throughput in a high volume operation. Average test volume in decentralized programs is low enough to easily absorb the additional test time involved (although at a cost in labor time). Equipment costs are analyzed in terms of the additional cost to equip each inspection site (i.e., each inspection lane in centralized inspection networks, and each licensed inspection station in decentralized networks).

By focusing on the inspection lane or station as the basic unit of analysis, the resulting cost estimates are equally applicable in large programs, with many subject vehicles and inspection sites, or small programs, with few subject vehicles and inspection sites. Previous EPA analyses of costs in I/M programs have found that the major determinants of inspection costs are test volume and the level of sophistication of the inspection equipment. Costs of operating programs were not found to be measurably affected by the size of the program (for further information the reader may refer to EPA's report entitled, "I/M Network Type: Effects on Emission Reductions, Cost, and Convenience"). Figures on inspection volumes at inspection stations and lanes are available from I/M program operating data. This information enables the equipment cost per vehicle and the additional staff cost per vehicle to be calculated for each test procedure.

The equipment cost figures presented in this paper are based on the costs of the equipment EPA believes is best suited for high-tech testing. They are current prices quoted by manufacturers, and do not reflect what the per unit prices might be if this equipment were purchased in volume. Staff costs are based on prevailing wage rates for inspectors in both types of programs as reported in conversations with state I/M program personnel. Construction costs in centralized programs are based on estimates supplied by centralized contractors. Other site costs and management overhead in centralized programs are back calculated from current inspection costs. For decentralized networks, it is assumed that longer test times could be absorbed with no increase in sites. The current average volume in decentralized stations is 1,025 vehicles per year (between 3 and 4 vehicles per day, depending upon the number of days per year the station is open). Consequently, increasing the length of the test, to the degree that the new procedures would, is not expected to impact the number of inspections that can be performed.

5.2.2 Equipment Needs and Costs

A pressure metering system, composed of a cylinder of nitrogen gas with a regulator, and hoses connecting the tank to a pressure meter, and to the vehicle's evaporative system is needed to perform evaporative system pressure testing. Hardware to interface the metering system with a computerized analyzer is also needed and is included in the cost estimate. Purge testing can be performed by adding a flow sensor with a computer interface, a dynamometer, and a Video Driver's Aid. With the further addition of a Constant Volume Sampler (CVS) and a flame ionization detector (FID) for HC analysis, two nondispersive infrared (NDIR) analyzers for CO and carbon monoxide (CO_2), and a chemiluminescent (CI) analyzer for NO_x, transient testing can be performed.

The analyzers used for the transient test are laboratory grade equipment. They are designed to higher accuracy and repeatability specifications than the NDIR analyzers used to perform the current I/M tests. Table 5-4 shows the estimated cost of equipment for conducting high-tech tests. This quality of technology is essential for accurate instantaneous measurements of low concentration mass emission levels.

Table 5-4
Equipment Costs for New Tests

Test	Equipment	Price
Pressure	Metering System	$600
Purge	Flow Sensor	$500
	Dynamometer	$45,000
	Video Drivers Aid	$3,000
Transient	CVS & Analyzers	$95,000
	TOTAL	$144,100

The figures in Table 5-4 do not include the costs of expendable materials. Nitrogen gas is used up in performing the pressure test. Additionally, the FID burns hydrogen fuel. Calibration gases are needed for each of the analyzers used in the transient test. Because the analyzers used in the transient test are designed to more stringent specifications than the analyzers currently used in the field, bi-blends, gaseous mixtures composed of one interest gas in a diluent (usually nitrogen) are used to calibrate them. Multi-blend gases, such as are typically used to calibrate current I/M equipment, are not suitable. Current estimates for expendables are shown in Table 5-5. The replacement intervals are estimated based on the usage rates observed in the EPA Indiana pilot program and typical inspection volumes as presented later in this section. Calculations of per vehicle equipment costs presented throughout this report include per vehicle costs of these expendables as well.

Table 5-5
Expendables for New Tests

			Replacement Interval	
Test	Material	Cost	Centralized	Decentralized
Pressure	N2 Gas	$30	250 tests	250 tests
Transient	H2 Fuel	$60	2 months	1000 tests
	HC Cal Gas	$60	2 months	1000 tests
	CO Cal Gas	$60	2 months	1000 tests
	CO_2 Cal Gas	$60	2 months	1000 tests

Staff costs have been found to vary between centralized and decentralized programs, as does the effect on the number of sites in the network infrastructure. Therefore, the following sections are devoted to separate cost analyses for each network type.

5.2.3 Cost to Upgrade Centralized Networks

5.2.3.1 Basic Assumptions

The starting point in this analysis is the current average per vehicle inspection cost in centralized programs. A figure of $8.50 was used based upon data from operating programs. This figure includes the cost of one or more retests and network oversight costs. The key variables to consider in estimating the costs in centralized networks are throughput, equipment, and staff costs. Data on these variables were obtained by contacting program managers in a number of these programs, and by surveying program contracts and Requests for Proposal.

Throughput refers to the number of vehicles per hour that can be tested in a lane. The higher the throughput rate, the greater the number of vehicles over which costs are spread, and the lower the per vehicle cost. EPA contacted program managers and consulted the contracts in a number of centralized programs to determine peak period throughput rates in the different systems. Rates were as reported in Table 5-6.

Table 5-6
Peak Period Throughput Rates in Centralized I/M Programs

Program	Vehicles Tested per Hour
Arizona	20
Connecticut	25-30
Illinois	25
Maryland	25-35
Wisconsin	25-30

On the basis of this informat ion, 25 vehicles per hour was assumed to represent the typical peak period throughput rate or design capacity in centralized I/M programs. During off-peak hours and days, throughput is lower since there is not a constant stream of arriving vehicles. Conversations with individuals in the centralized inspection service industry indicate that inspectors start at minimum wage or slightly higher, that by the end of the first year they earn $5.50 to $6 per hour, and that they generally stay with the job for one to three years. Thus, $6 per hour was used to estimate the average inspector's hourly wage.

Estimates of the costs of adding pressure testing, purge testing, and transient tailpipe testing were derived by taking the current costs for the new equipment to perform the new tests, dividing it by the number of inspections expected to be performed in the lane over a five year period and adding it to the current $8.50 per vehicle cost, with a further adjustment for the impact of test time on throughput, and thus on the number of sites and site costs. The same is done to estimate additional personnel costs associated with adding the new tests. When independent programs were surveyed to determine the length of a typical contract, it was discovered that Illinois, Florida, and Minnesota all have five year contracts, Arizona has a seven year contract, and the program in the State of Washington is operating under a three year contract, resulting in an average contract length of five years among the five programs surveyed. Five years was therefore chosen as the typical contract length.

The number of inspections expected to be performed over the five year contract period was derived by calculating the total number of hours of lane operation, estimating the average number of vehicles per lane and multiplying the two. A lane is assumed to operate for 60 hours a week (lane operation times were found to vary from 54 to 64 hours per week), 52 weeks a year for five years for a total of 15,600 hours. Lanes are assumed to have a peak throughput capacity of 25 vehicles per hour. Modern centralized inspection networks are designed so that they can accommodate peak demand periods with all lanes operating at this throughput rate. Networks are usually designed so that average throughput is 50-65% of peak capacity or 13-15 vehicles per hour. When operating for 15,600 hours over the life of a contract, a centralized inspection lane is estimated to perform a total of 195,000 inspections, or about 39,000 per year.

5.2.3.2 The Effect of Changing Throughput

The addition of evaporative system pressure testing to a centralized program would result in a slight decrease in the throughput capacity. The addition of purge and transient testing, along with pressure testing, would result in a further decrease.

Assuming the same test frequency (i.e., annual or biennial) the reduced throughput rate means that the number of lanes needed to test a given number of vehicles would increase accordingly, as would the size of the network infrastructure needed to support the test program. The result is an increase in the cost per vehicle. Actual consumer cost depends on the test frequency; EPA would encourage states to adopt biennial programs to reduce the costs and imposition of the program. Less frequent testing only slightly reduces the emission reduction benefits while cutting test costs almost in half.

One way to estimate the cost would be to simulate an actual network of stations and lanes in a given city. One could attempt to assess land costs, building costs, staff and equipment costs, costs for all necessary support systems, and other cost factors. However, this approach would be very time consuming and would rely on information which is proprietary to the private contractors that operate the programs and is, therefore, unavailable. Instead, the cost of the increased number of lanes and stations is derived by analyzing current costs and subtracting out equipment, direct personnel, construction, and state agency oversight costs. The remainder is adjusted by the change in throughput in the new system. Then, new estimates of equipment, personnel, construction, and oversight costs are added back in to obtain the estimated total cost.

As discussed previously, the typical high volume station can test 25 vehicles per hour, performing (in most cases) a test consisting of 30 seconds of high speed preconditioning or testing, followed by 30 seconds of idle testing. In addition, a short time is spent getting the vehicle into position and preparing it for testing. This leads to a two to three minute test time on average, depending upon what short test is performed. EPA recently issued alternative test procedures for steady-state tests that reduce various problems associated with those tests, especially false failures, but at a cost of longer average per test time.

Current costs were estimated by contacting operating program personnel, equipment vendors and contractors. The most sophisticated equipment installation (i.e., the equipment for loaded steady-state testing) was used to estimate current equipment costs.

The cost to acquire and install a single curve dynamometer and an analyzer in existing networks is about $40,000 or 21¢ per vehicle using the basic test volume assumptions. As indicated previously, a staff person is assumed to earn $6.00 per hour. When this figure is multiplied by 15,600 total contract hours and divided by 195,000 vehicles, direct staff costs are estimated at 48¢ per vehicle. Existing centralized networks typically have two staff per lane. Thus, total staff costs work out to 96¢ per vehicle. Total average construction costs are estimated at $800,000 for a five lane station, yielding an average per vehicle cost of 82¢. In this analysis a figure of $1.25 is used to estimate the amount of the state retainer. This reflects EPA's best estimate of the per vehicle expense for a good state quality assurance program in a centralized network. Equipment, staff, construction, and state costs add up to $3.24 per vehicle. Subtracting this amount from the current average of $8.50 leaves $5.26 in infrastructure costs and other overhead expenses including employee benefits and employer taxes as shown in Table 5-7. This amount is then factored by the change in the throughput rate and the equipment, oversight, and staff costs for the new tests are then added.

Table 5-7
Current Program Costs

Increments	Per Vehicle Cost	Total Cost Less Increments
Current		$8.50
Equipment	$0.21	$8.29
Staff	$0.96	$7.33
Construction	$0.82	$6.51
State Retainer	$1.25	$5.26

5.2.3.2 Costs of New Tests

Most centralized programs use a two position test queue; emission test are done in one position while emission control devices are checked in the other, along with other functions such as fee collection. In this type of system the throughput rate is determined by the length of time required to perform the longest step in the sequence, not by length of the entire test sequence. The new tests would likely be performed in a three position test queue, with one position dedicated to fee collection and other administrative functions, one to performing the pressure test, and the third to performing the transient and purge tests. The transient/purge test is a longer test procedure than the ones currently used in most I/M programs and is the longest single procedure in the whole inspection process. Thus, it is the determining factor in lane throughput and will therefore influence the number of test sites required.

The transient test takes a maximu m of four minutes to perform. An additional minute is assumed to prepare the vehicle for testing, for a maximum total of five minutes. The pressure test would take approximately two minutes, and could be shortened through such potential strategies as computerized monitoring of the rate of pressure drop. EPA is in the process of looking at potential fast-pass and fast-fail strategies, and preliminary results suggest that roughly 33% of the vehicles tested could be fast passed or failed based upon analysis of data gathered during the first 93 seconds of the IM240 (i.e., Bag 1) using separate fast-pass and fast-fail cutpoints. Hence, EPA estimates that the average total test time could be shortened to at least four minutes per vehicle. This translates into a throughput capacity of 15 vehicles per hour. To accommodate peak demand periods and maintain short wait times, a design throughput rate of half of capacity is assumed, for a typical throughput rate of 7.5 vehicles per hour. Assuming the same number of hours of lane operation as previously, the total number of tests per lane in a transient lane is estimated to be 117,000 over the five year contract period.

State quality assurance program costs would increase given the complexity and diversity of the test system; an estimate of an additional 50¢ is used here but the amount could vary depending upon the intensity of the oversight function the state chooses. Staff costs per vehicle are calculated using the same assumptions for wages and hours of operation as shown in Table 5-7; however, the cost is spread over 117,000 tests over the life of the contract rather than 195,000. The result is staff costs of 80¢ per staff per vehicle. Three staff per lane are assumed to perform the tests. The additional tasks performed by inspectors in conducting the new tests - i.e., disconnecting vapor lines and connecting them to analytical equipment for the evaporative tests and driving the vehicle through the transient driving cycle - do not require that inspectors have higher levels of skill than they do presently. Rather, these tasks can be performed by comparably skilled individuals trained to these specific tasks. Total staff costs work out to $2.40 per vehicle. Equipment costs for each test procedure are derived by taking the equipment costs from Table 5-4 and calculating the costs of five years worth of expendables using the figures in Table 5-5 and dividing by 117,000. Construction costs for a five lane station are assumed to rise to $1,000,000. This is due to the fact that slightly longer lanes may be needed in order to accommodate test equipment and facilitate faster throughput. Dividing this figure by 117,000 vehicles per lane yields a per vehicle cost of $1.71. The resulting costs estimates are shown in Table 5-8. Table 5-8 shows the result of factoring the figure of $5.26, from Table 5-7, by the change in the throughput rate and adding in the equipment, staff, construction and state costs associated with the new test procedures. The figure of $5.26 is multiplied by 12.5/7.5, i.e., the ratio of the design throughput rate in the current program to the design throughput rate in a program conducting pressure purge and transient testing.

Table 5-8

Costs to Add Proposed Tests to Centralized Programs

Increments	Per Vehicle Cost	Running Total Cost per Vehicle
Adjust for Throughput	$5.26 * 12.5/7.5	$9.12
Staff	$2.40	$11.52
Construction	$1.71	$13.23
Oversight	$1.75	$14.98
Pressure Test	$0.13	$15.11
Purge Test	$0.41	$15.52
Transient Test	$0.87	$16.40

Thus, the c ost of adding the new tests to centralized networks is found to be about double the current average cost. The cost of centralized test systems has been dropping in the past few years as a result of competitive pressures and efficiency improvements. These factors may drive down the costs of the new tests as well, especially as they relate to equipment costs. Given that conservative assumptions were made regarding equipment costs of $144,000 per lane, and low throughput rates, the cost estimate presented here can be fairly viewed as a worst case assumption. As discussed earlier, the important issue is the quality of the test, not the frequency, so doing these tests on a biennial basis would offset the increased per test cost.

5.2.4 Cost to Upgrade Decentralized Programs

5.2.4.1 Basic Assumptions

The methodology used to estimate costs in decentralized programs is similar to that described above for centralized programs. Equipment and labor costs are key variables as they were in determining costs for centralized programs. However, estimates of costs for decentralized programs presented here do not include estimates of land costs and overhead. While inspections in decentralized programs are generally conducted in pre-existing facilities rather than newly built ones, there are nonetheless a variety of overhead expenses as well as opportunity costs associated with making space available for inspections in a facility that provides a number of other services as well. Data on these costs are not available and they cannot be deduced from reported inspection fees since, in most programs, fees are capped by law and, hence, do not reflect the actual cost of providing an inspection.

Total test volume rather than throughput and test time are the critical factors affecting cost in decentralized programs. Licensed inspection stations at present only perform, on the average, about 1,025 inspections per year, as shown in Table 5-9 (note that this number is a station-weighted average). Test volumes among stations in a single program can vary widely as shown in Section 7.0. It should also be noted that all decentralized programs in enhanced I/M areas, except for California, Virginia, and Colorado (which tests vehicles five years old and newer biennially, and vehicles older than five years annually) are annual programs. In this analysis the effect on per vehicle costs of switching from an annual inspection frequency to biennial, as well the effect of varying inspection volume, will be examined.

Table 5-9
Inspection Volumes in Licensed Inspection Stations

Program	Vehicles per Year	Vehicles per Station
California	6,180,093	799
Colorado	1,655,897	1,104
Dallas/Ft. Worth	1,948,333	1,624
El Paso	278,540	1,161
Georgia	1,118,448	1,729
Houston	1,482,349	1,348
Louisiana	145,175	1,037
Massachusetts	3,700,000	1,321
Nevada	523,098	1,260
New Hampshire	137,137	564
New York	4,605,158	1,071
Pennsylvania	3,202,450	834
Rhode Island	650,000	684
Virginia	481,305	1,301
Weighted Average		1,025

Annual tests of 1,025 vehicle s per station is equivalent to between three and four inspections per day depending upon the number of days per week the facility is open and inspections are available. This is far below the 75 inspections per day projected in a multi-position high volume lane with three inspectors conducting high-tech tests, and significantly below the 16 inspections per day that could be done in a single position inspection bay with only one inspector (the derivation of this figure is detailed below). Two conclusions can be drawn from this. The first is that the additional time requirements of the new tests will not force a reduction in the total number of inspections that most stations can perform. The second is that, because costs are spread over a smaller number of vehicles than in the case of high-volume, centralized stations, the cost per vehicle for the new tests will be larger in this type of inspection network.

The higher costs for high-tech testing equipment have prompted questions of whether all current inspection stations would choose to stay in the inspection business with the implementation of an enhanced program, and how high a drop-out rate programs would experience if some did not. EPA knows of no data or reasonable assumptions by which a station drop-out rate could be reliably estimated. In this analysis inspection costs for high-tech testing are estimated for three scenarios: one where all stations remain in the inspection business, one where 50% of the stations drop out, and one where enough stations drop out such that those that remain are operating at maximum possible volume assuming that each has one inspection bay which has not been improved for high throughput and one inspector performing all parts of the inspection. In all three scenarios a biennial inspection frequency is assumed.

The current average test fee for vehicle inspection in decentralized programs is about $17.70 (again, the derivation of this figure can be found in EPA's technical information document, "I/M Network Type: Effects on Emission Reductions, Cost, and Convenience"). Note that this figure may substantially underestimate actual costs since most states limit the inspection fee that a station may charge. In many cases, the actual fee is likely to be below cost; stations presumably obtain sufficient revenue to stay in business by providing other services, which may include repair. It should also be noted that the intensity of the inspection and the sophistication and cost of the analyzer vary significantly among programs. Average inspection costs and revenues by program, taking these factors into account, are estimated in Section 7.4.1.

The costs for adding high-tech tests are derived by estimating the per vehicle costs of the key components: labor; equipment, including expendables; and support, i.e., service contracts and annual updates. Per vehicle costs are estimated by deriving total costs for each component and dividing by the number of vehicle inspections expected to be performed in a year, again, taking into account variations in inspection volumes and changes in frequency. Equipment costs are spread over the useful life of the equipment. While a piece of equipment's useful life can vary considerably in actual practice, a five year equipment life is assumed.

While large businesses, such as dealerships, may be able to afford to purchase current analyzer equipment outright, the smaller gas stations and garages typically have to finance these purchases (although in some cases they may lease equipment). The higher cost of the equipment needed to perform purge and transient testing ($144,000 for the dynamometer, CVS, analyzers, etc., as opposed to $12,000 to $15,000 for the most sophisticated of the current NDIR-based analyzers) makes it even more likely that these purchases will have to be financed for most inspection stations. Equipment costs are amortized over five years at 12% interest in the analysis in this report.

Program personnel in decentralized programs were contacted to determine inspector wage rates. In many cases, inspectors are professional mechanics earning about $25 per hour. However, most states do not require inspectors to be mechanics, and inspections may be performed by less skilled individuals who typically earn $6 or $7 per hour. The prevalence of different wage rates among inspectors is unknown. Therefore, EPA assumed an average wage of $15 per hour for this analysis. An overhead rate of 40% is assumed, for a total labor cost of $21 an hour.

5.2.4.3 Cost Components and Scenarios

The full test, including data entry on the computer, preparing the vehicle for the different steps in the test procedure and conducting them, is estimated to take 30 minutes with only one inspector performing all tasks in a repair bay that is not configured specifically for inspection throughput. With labor costs at $21 per hour, as described above, this works out to $11.50 per vehicle. Equipment costs are taken from Table 5-4 and are amortized over a five year period at 12 percent annual interest (changing the assumed interest rate does not significantly affect the total per vehicle cost). This brings the total cost for the equipment package over the five year period to $192,325. These costs are divided by five years worth of inspections. The costs of expendables from Table 5-5 are added in according to the usage rates assumed for decentralized programs. Two other expenses typically encountered in decentralized programs are service contracts and software updates. Based on information from states, service contracts are estimated at $200 per month and annual software updates are assumed to cost $1,500.

Per vehicle costs are estimated for three scenarios, biennial testing is assumed in all three. In the first, all stations remain in the inspection program. In the second, 50 percent of the stations drop out of the program, and in third there are only the minimum number of stations in the program to enable each to inspect at full volume with one inspector performing all parts of the inspection and a service station bay that has not been improved for high throughput.

In the first scenario, the switch to biennial would mean that annual volume is cut in half, or 513 vehicles per year. In the second scenario the 50 percent reduction in the number of stations brings the annual inspection volume back to 1,025. In the fourth scenario, it is assumed that each station inspects at maximum capacity, i.e., one vehicle every thirty minutes, and that an inspector is available 50 hours per week. This results in an annual volume of 5,200 vehicles.

Table 5-10
Costs to Conduct High-Tech Testing in Decentralized Programs

Scenario	Annual Volume	Cost per Vehicle
No Drop-out	513	$106
50% Drop-out	1,025	$58
72% Drop-out (Maximum volume)	5,200	$32

Note that while reducing inspection frequency to biennial cuts motorists' costs in centralized programs, in decentralized programs such cost reductions are only achieved by reducing opportunities for stations to participate. In the scenario in which 50 percent of the stations drop out and testing is biennial, annual station volume is the same as if testing were annual and no stations dropped out. Hence, the estimated per vehicle cost in a biennial program with a 50 percent station drop-out rate is the same as would be derived for an annual program with no stations dropping out. Reducing inspection frequency to biennial, while maintaining the same number of stations, has the effect of almost doubling the per vehicle cost since operating costs are spread over half as many vehicles. Note also that the per vehicle cost far exceeds the per vehicle cost in centralized programs except in the scenario where 72 percent of the stations drop-out.

5.3 Costs of Four-Mode, Purge and Pressure Testing

It has been proposed that a series of simpler, loaded mode and other steady-state tests would provide equivalent emission reductions to the IM240 at a lower cost. The emission reduction potential of this approach is currently being evaluated at EPA's test lane in Phoenix, Arizona. The information needed to do a cost analysis can be approximated at this time based upon the test process.

The test procedure being evaluated is a series of emission tests referred to as the four-mode test: A 40 second 5015 mode (15 mph at a load equivalent to ETW / 250), a 40 second 2525 mode (25 mph at load equivalent to ETW / 300), a 40 second mode at 50 mph and normal road load, and a 40 second idle mode. EPA anticipates a 30-60 second preconditioning mode would be needed to insure proper warm-up and canister purge down. Allowing also for necessary time to transition between test modes (5-10 seconds), the four-mode test would require a total of approximately four minutes. As with the IM240-based test scenario, purge testing is assumed to occur simultaneously with the tailpipe test and pressure testing would be done separately. It should be noted, however, that some vehicles may not purge during this test and may require a short transient retest to activate purge.

5.3.1 Equipment and Expendables

The equipment used for the four-mode test is simpler than for the IM240 test. The dynamometer may not need inertia weights, and a raw gas analyzer, like the ones used in the current I/M tests, is upgraded with a NOx analyzer and an anemometer, to enable mass concentration calculations, for this test. The equipment for the purge and pressure test are the same as described previously. The estimated costs are shown in Table 5-11.

Table 5-11
Equipment and Costs for the ASM Test

Pressure System	$600
Flow Sensor	$500
Dynamometer	$20,000
Anemometer	$2,000
BAR90 w/NOx Analyzer	$16,900
Total	$40,000

Expendables for this test are nitrogen gas for the pressure test and calibration gases for the analyzer. The cost of nitrogen gas is the same as in the previous analysis on IM240 costs (the pressure test procedure is the same regardless of the type of tailpipe test used). Current calibration gases are multi-blends consisting of propane, CO, and CO2. A cost of $45 per bottle is used here. In this analysis, it is assumed that multi-blend gases that include NO will be available at the same cost. Alternatively, one could assume that two bottles of calibration gas, one current standard multi-blend and a bottle of NO will be needed, however, the additional cost per test is insignificant (less than 5¢, even in a low volume situation).

5.3.2 Centralized Programs

The total test time per vehicle would be about 11 minutes, including administrative processing in an efficiently run testing lane. In a multi-position lane the throughput would be governed by test time at the longest position, which would be four minutes. This translates into a peak throughput rate of 15 vehicles per hour and, using the standard design criteria for centralized programs described earlier, an average throughput of 7.5 vehicles per hour. Using the lane operation assumptions detailed earlier, this translates into 23,400 vehicles per lane per year and 117,000 vehicles over an assumed five year contract period. Three staff per lane would be needed to perform the entire test sequence including inputting vehicle identification information, conducting the tests and presenting and explaining the results to the motorist.

The per vehicle cost of the four-mode test in centralized programs is estimated by the same methodology as was used to estimate IM240 costs. Current costs for test equipment, staff, state oversight, and construction are subtracted from the current average per vehicle cost, this amount is factored by the change in throughput, and estimated costs for equipment, staff, construction, and state oversight in a four-mode test program are added to obtain an estimated total cost.

Table 5-12
Costs to Add Proposed Tests to Centralized Programs

Increments	Per Vehicle Cost	Running Total Cost per Vehicle
Adjust for Throughput	$5.26 * 12.5/7.5	$9.12
Staff	$2.40	$11.52
Construction	$1.71	$13.23
Oversight	$1.75	$14.98
Pressure Test	$0.13	$15.11
Purge Test	$0.18	$15.29
Four-mode Test	$0.35	$15.64

5.3.3 Decentralized Programs

The same methodology used t o estimate costs of IM240 testing is used here. Most assumptions are unchanged. Total test time is thirty minutes, equipment is amortized over a five year period. Two parameters are changed in this analysis: equipment costs total $40,000 instead of $144,100, and state costs include a cost for state mass emission testing.

Table 5-13
Costs to Conduct Four-Mode Testing in Decentralized Programs

Scenario	Annual Volume	Cost per Vehicle
No Drop-out	513	$51
50% Drop-out	1,025	$31
72% Drop-out	5,200	$25

Appendix I:

ASM and IM240 Credits for State Implementation Plans With MOBILE5 Runs

Appendix J:

Emissions Analyzer Price Information from Horiba

HORIBA

HORIBA INSTRUMENTS INCORPORATED
3901 Varsity Drive, Ann Arbor, Michigan 48108
Telephone: (800) 3 HORIBA In Mich. (800) 624-3839 or (313) 973-2171
Fax: (313) 973-7868

April 7, 1993

Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, MI 48105

Attn: Mr. Bill Pidgeon

Re: IM 240 Analyzer Information

Dear Mr. Pidgeon:

This letter is a follow-up to prior discussions we've had regarding the list price of IM 240 Analyzer Systems. We would like to thank you for the opportunity of discussing our equipment and market with you and your staff.

We would like to make a clarification in reference to the IM 240 pricing. Horiba is actively working with six of the seven centralized contractors. Four of these contractors currently have IM 240 analyzers installed. The current list price for the Analyzer/CVS System is $75,515. It should be noted that this price does not include a blower or external sample line. As you can understand, this is a "single unit price" and does not reflect discounting for quantity orders. For long-term pricing considerations, it should be recognized that we also anticipate price reductions following improvements in manufacturing efficiencies.

Horiba's analytical system can be supplied with other options, such as: a driver's aid, purge and pressure equipment, data collection and processing capabilities.

<u>IM 240 Analyzer System</u>

HC - FID
CO - NDIR
CO_2 - NDIR
NOx - Chemiluminescent
CVS - 500-700 CFM

Total: $75,515

We feel that our forte' is in the analytical and sample handling portion of the testing lane. For this reason, we are providing you with analytical system pricing only. Most of our customers have sourced or built the other components themselves.

If you should have any additional comments or questions, please feel free to contact me at 1-800-3HORIBA.

Sincerely,

Kenneth W. Thomas
Marketing Manager,
IM Systems

KWT/pm

cc: Neal Harvey
Andy Marko

kt041.ltr

Appendix K:

Centrifugal Blower Price Quotation

from Combined Fluid Products Company

COMBINED FLUID PRODUCTS COMPANY

QUOTATION

ISSUED FROM

☐ 806 Oakwood Rd., Lake Zurich, IL 60047
Phone (708) 540-0054 FAX (708) 540-0810

☐ 128 N. Executive Dr., Brookfield, WI 53005
Phone (414) 258-7770 FAX (414) 821-1492

☐ P.O. Box 216, 24 S. Green St., Brownsburg, IN 46112
Phone (317) 852-3981 FAX (317) 852-2037

☒ 5025 Venture Dr., Ann Arbor, MI 48108
Phone (313) 930-2024 FAX (313) 747-7540

Please Note:
A/R Dept. is located in Lake Zurich, Illinois

TO: Environmental Protection Agency
2565 Plymouth Road
Ann Arbor, Michigan 48105

ATTENTION: Mr. Dan Sampson

EFFECTIVE DATE: January 27, 1993

REFERENCE:

EXPIRATION DATE: February 27, 1993

QUOTATION NO.: AA406

In Compliance With Your Request We Are Pleased to Quote You As Follows

QUANTITY	DESCRIPTION	PRICE
1-10	Paxton Centrifugal Blower Model RM-87, including: 10 HP electric motor running at 3,600 RPM on 230/460 volt vacuum, three-phase, 60 Hz, TEFC motor. - Inlet Filter/Silencer	$3,320.00 Per Unit Net
11-100	....	$2,656.00 Per Unit Net

DELIVERY: Six to eight weeks F.O.B. Santa Monica, California (Delivery Subject to Prior Sale)

TERMS: Net 30 Days, Subject To Credit Approval

COMBINED FLUID PRODUCTS CO.

Scott F. Carruther, Sales Engineer

This quotation subject to standard terms and conditions of sale as stated on reverse side.
Please use the Acceptance form to place your order.

Appendix L:

Average IM240 Test Time Utilizing

Preliminary Fast-Pass and Fast-Fail Algorithms

Average IM240 Test Time Utilizing Preliminary Fast-Pass and Fast-Fail Algorithms

The objective of this analysis was to estimate the average IM240 test time using algorithms that allow vehicles with very low emissions to fast-pass and vehicles with very high emissions to fast-fail. This reduces the average time required for the IM240, allowing higher throughput, which reduces the number of inspection lanes required. The reduced number of lanes lowers equipment and personnel costs, having the potential to significantly improve the cost effectiveness of the I/M program.

This analysis describes the fast-pass and fast-fail algorithms used to estimate the average IM240 test time. The results are preliminary, representing what could be achieved in time to comply with the court ordered deadline for this rulemaking. Developing these algorithms requires using second-by-second data for HC, CO, NOx, and purge, which is very time consuming, given the huge amount of data per vehicle.

The ideal fast-pass/fast-fail algorithm consists of two continuous functions. One function represents emission levels at each second of the IM240 that reliably predict a passing result while the other function represents emission levels that reliably predict a failing result. Because this requires evaluating the results at each second of the test for each of the vehicles, we determined that this could not be achieved under the time constraint. Instead, we evaluated nine segments (modes) of the IM240, which significantly reduces the burden, but gives a less than optimal result.

So, additional fast-pass and fast-fail algorithms will be evaluated in the future, and additional vehicles will be available for those analyses, so these results should be regarded as preliminary. For example, very low emitters or extremely high emitters can be fast-passed or fast-failed early in the IM240 cycle, while vehicles near the certification emission levels will require more time to accurately predict a passing or failing result. The emission reduction benefits, obtained from repairing vehicles whose emission levels are slightly dirtier than their certification standards, are not very cost effective. Similarly, it also may not be cost effective to run the full IM240 as required to accurately distinguish marginal emitters that pass the full IM240 from marginal emitters that fail. This can be evaluated by comparing IDRs, failure rates, and error of commission rates for each second of the IM240 to determine the best tradeoff.

Another consideration is the IM240 reversed. The IM240 was designed as a two-mode test. The second mode includes the maximum speed of 56.7 mph. The

IM240-reversed starts with this high speed mode, then is followed by the low speed mode. This may further reduce the average test time required to distinguish malfunctioning cars from properly functioning cars. It should be especially helpful in rapidly determining whether the purge system is performing adequately.

The algorithm used in this analysis was comparatively crude due to time and data handling constraints. Several discrete modes of the IM240 were selected for determining passing and failing emission levels. These modes were selected to avoid ending the test during an acceleration or deceleration and to provide a reasonable duration for each of the nine modes. The average IM240 test time was calculated as the average of the selected mode times weighted by the number of vehicles passing or failing at each mode. A more detailed description of the data and methodology used as well as the results are included in the following sections.

The database used for this analysis conformed to the model I/M program, so it was limited to 1986 and newer vehicles with second-by-second IM240 results - 494 vehicles. These vehicles were tested between June 4, 1992 and August 4, 1992. Data were only used if the composite results calculated from the second-by-second data had passed EPA’s quality control measures. Due to the volume of second-by-second data and the time constraints involved, the second-by-second data were not QC'd separately.

The following nine modes were selected for pass/fail determinations:

Modes For Evaluating Fast-Pass And Fast-Fail

Mode (#)	IM240 Mode (secs.)	IM240 Speed @ End of Mode (mph)
1	0 - 34	22.6
2	0 - 60	30.4
3	0 - 74	29.8
4	0 - 93	0.0
5	0 - 113	27.2
6	0 - 154	26.0
7	0 - 173	47.2
8	0 - 206	51.6
9	0 - 239	0.0

To determine the passing and failing emission levels for each mode, the sample was divided into passing and failing vehicles. The pass/fail determination was made based on the "two ways to pass" criteria with 0.8 g/mi

HC, 15.0 g/mi CO and 2.0 g/mi NOx as composite IM240 cutpoints and, 0.5 g/mi HC and 12.0 g/mi CO bag 2 cutpoints. One liter of purge volume was used as the cutpoint for purge flow. These criteria are illustrated below.

Pass/Fail Decisions Based On Two-Ways-To-Pass-Criteria

Decision	**IM240** HC g/mi	**IM240** CO g/mi	**Bag 2** HC g/mi	**Bag 2** CO g/mi	**IM240** NOx g/mi	**Purge** liters	**Comments**
Fail	> **0.8**	≤ 15.0	> **0.5**	≤ 12.0	≤ 2.0	≤1.0	Must fail HC on both Composite & Bag 2 to fail.
Fail	≤ 0.8	>**15.0**	≤ 0.5	>**12.0**	≤ 2.0	≤1.0	Must fail CO on both Composite & Bag 2 to fail.
Fail	≤ 0.8	≤ 15.0	≤ 0.5	≤ 12.0	> **2.0**	≤1.0	Only 1 way to Pass: Composite NOx ≤ 2.0 to pass.
Fail	≤ 0.8	≤15.0	≤0.5	≤12.0	≤ 2.0	**≥1.0**	
Pass	≤ 0.8	≤ 15.0	≤ 0.5	≤ 12.0	≤ 2.0	≤1.0	
Pass	> **0.8**	>**15.0**	≤ 0.5	≤ 12.0	≤ 2.0	≤1.0	
Pass	≤ 0.8	≤ 15.0	> **0.5**	>**12.0**	≤ 2.0	≤1.0	
Pass	> **0.8**	≤ 15.0	≤ 0.5	≤ 12.0	≤ 2.0	≤1.0	
Pass	≤ 0.8	≤ 15.0	> **0.5**	≤ 12.0	≤ 2.0	≤1.0	
Pass	≤ 0.8	>**15.0**	≤ 0.5	≤ 12.0	≤ 2.0	≤1.0	
Pass	≤ 0.8	≤ 15.0	≤ 0.5	>**12.0**	≤ 2.0	≤1.0	

The minimum emission levels and maximum purge volume for failing vehicles at each mode were used as fast-pass cutpoints. Conversely, the maximum emission levels for passing vehicles at each mode were used as fast-fail cutpoints. Vehicles were not fast-failed based on purge results since many vehicles purge late in the IM240 cycle. As mentioned, the IM240-reversed may help rapidly determine if the purge system is functioning adequately.

The modal cutpoint levels, the number of vehicles fast-passing or fast-failing at each mode and the average IM240 test time as a result of the application of this fast-pass/fast-fail algorithm are displayed in the following table.

Mode #	Time (sec)	Fast-pass Cutpoints <HC/CO/NOx >Purge	Number of Vehicles Fast-passing	Fast-fail Cutpoints >HC/CO/NOx	Number of Vehicles Fast-failing	Number of Vehicles Fast-passing and Fast-failing	Time * Number of Vehicles with Fast Result
1	0-34	<0.479/1.02/0.99 >0.1	16	>3.405/56.72/7.30	15	31	1054
2	0-60	<0.487/0.89/0.99 >0.3	2	>1.891/47.30/4.63	22	24	1440
3	0-74	<0.429/0.929/0.90 >0.3	1	>1.648/38.09/3.58	7	8	592
4	0-93	<0.377/0.921/0.84 >0.4	0	>1.536/41.09/3.19	9	9	837
5	0-113	<0.460/0.932/0.89 >0.5	3	>1.518/36.78/3.02	6	9	1017
6	0-154	<0.567/1.088/0.96 >0.6	3	>1.296/30.34/2.57	11	14	2156
7	0-173	<0.697/3.52/1.33 >0.7	65	>1.120/25.22/2.65	11	76	13148
8	0-206	<0.916/14.99/1.77 >0.8	210	>0.915/18.06/2.33	35	245	50470
9	0-239	²0.805/15.05/2.05 ³1.0	45	>0.805/15.05/2.05	33	78	18642
		Weighted Sum with Fast-pass Only	102410			Weighted Sum	89356
		Average IM240 Test Time with Fast-pass Only =	207 sec			Average IM240 Test Time =	180 sec

These results indicate that the test time for the IM240 can be reduced by 25% when fast-pass/fast-fail criteria are applied and a reduction of over half a minute occurs when only fast-pass criteria are applied. Using only fast-pass criteria allows for the collection of diagnostic data so that failing cars may be repaired more effectively.

Because Hammond cars with second-by-second data were typically shut off for 10 minutes, catalyst cool down could have caused high emissions during the early parts of the test and adversely affected fast-pass and fast-fail. Similarly, vehicles that drive a short distance to an I/M station may not be fully warmed up when they start the test. Therefore, additional analyses were performed without integrating over the first part of the IM240. In effect, utilizing the first segment of the IM240 as preconditioning. Three different integration starting points were used. Since the accelerations contribute the most toward catalyst light-off, these starting points follow the first three accelerations of the IM240 cycle. The integrations begin after 17, 35 and 47 seconds of the test. The results of these analyses are displayed here.

Mode #	Time (sec)	Fast-pass Cutpoints <HC/CO/NOx >Purge	Number of Vehicles Fast-passing	Fast-fail Cutpoints >HC/CO/NOx	Number of Vehicles Fast-failing	Number of Vehicles Fast-passing and Fast-failing	Time * Number of Vehicles with Fast Result
1	17-34	<0.525/0.95/1.33 >0.1	11	>2.643/76.94/10.33	19	30	1020
2	17-60	<0.504/0.54/1.10 >0.3	1	>1.892/53.86/5.11	11	12	720
3	17-74	<0.465/0.90/0.96 >0.3	4	>1.615/41.40/3.77	11	15	1110
4	17-93	<0.400/0.90/0.88 >0.4	0	>1.498/45.64/3.27	10	10	930
5	17-113	<0.486/0.91/0.93 >0.5	5	>1.484/40.16/3.08	7	12	1356
6	17-154	<0.593/1.09/1.00 >0.6	3	>1.265/32.27/2.66	10	13	2002
7	17-173	<0.641/3.08/1.38 >0.7	56	>1.080/26.48/2.71	10	66	11418
8	17-206	<0.826/15.33/1.82 >0.8	217	>0.936/18.44/2.32	37	254	52324
9	17-239	^{2}0.805/15.05/2.05 ^{3}1.0	48	>0.805/15.05/2.05	34	82	19598
		Weighted Sum with Fast-pass Only	103230			Weighted Sum	90478
		Average IM240 Test Time with Fast-pass Only	209 sec			Average IM240 Test Time	183 sec

Mode #	Time (sec)	Fast-pass Cutpoints <HC/CO/NOx >Purge	Number of Vehicles Fast-passing	Fast-fail Cutpoints >HC/CO/NOx	Number of Vehicles Fast-failing	Number of Vehicles Fast-passing and Fast-failing	Time * Number of Vehicles with Fast Result
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	35-60	<0.493/0.79/0.90 >0.3	19	>1.983/41.71/3.71	41	60	3600
3	35-74	<0.403/0.73/0.79 >0.3	4	>1.499/31.32/3.08	8	12	888
4	35-93	<0.340/0.69/0.75 >0.4	2	>1.450/55.71/3.09	5	7	651
5	35-113	<0.454/0.91/0.82 >0.5	5	>1.406/47.21/3.07	3	8	904
6	35-154	<0.585/1.10/0.93 >0.6	2	>1.299/35.99/2.59	7	9	1386
7	35-173	<0.575/2.85/1.37 >0.7	48	>1.061/28.83/2.81	7	55	9515
8	35-206	<0.795/15.17/1.84 >0.8	221	>0.966/19.48/2.37	35	256	52736
9	35-239	^{2}0.805/15.05/2.05 ^{3}1.0	44	>0.805/15.05/2.05	43	87	20793
		Weighted Sum with Fast-pass Only	102452			Weighted Sum	90473
		Average IM240 Test Time with Fast-pass Only	207 sec			Average IM240 Test Time	183 sec

Mode #	Time (sec)	Fast-pass Cutpoints <HC/CO/NOx >Purge	Number of Vehicles Fast-passing	Fast-fail Cutpoints >HC/CO/NOx	Number of Vehicles Fast-failing	Number of Vehicles Fast-passing and Fast-failing	Time * Number of Vehicles with Fast Result
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	47-60	<0.458/0.40/1.05 >0.3	6	>2.089/37.20/3.67	41	47	2820
3	47-74	<0.375/0.46/0.83 >0.3	9	>1.282/33.21/2.99	14	23	1702
4	47-93	<0.310/0.52/0.76 >0.4	5	>1.737/67.22/3.10	0	5	465
5	47-113	<0.434/0.94/0.85 >0.5	15	>1.619/54.68/3.08	2	17	1921
6	47-154	<0.594/1.14/0.96 >0.6	4	>1.355/39.55/2.55	8	12	1848
7	47-173	<0.550/2.88/1.43 >0.7	48	>1.095/30.98/2.82	4	52	8996
8	47-206	<0.751/14.82/1.91 >0.8	220	>1.004/20.39/2.42	35	255	52530
9	47-239	²0.805/15.05/2.05 ³1.0	38	>0.805/15.05/2.05	45	83	19837
		Weighted Sum with Fast-pass Only	102119			Weighted Sum	90119
		Average IM240 Test Time with Fast-pass Only	207 sec			Average IM240 Test Time	182 sec

These results indicate, that for the data used in this analysis, preconditioning has little effect on the average test time of the fast-pass/fast-fail algorithm used. In spite of this, these estimates are considered conservative for several reasons. First, older cars are excluded from the analysis. Since most grossly emitting vehicles are older vehicles, the inclusion of these cars would be expected to increase the number of fast-failing vehicles and reduce the test time further. However, this reduction may be offset by a reduction in the percentage of vehicles fast-passing. More important than the vehicle sample is the algorithm used. If a continuous function were used, actual test times could be used to calculate the average.

This should lead to significant time savings compared to using the last second of a particular mode as the required test time for all vehicles that pass or fail during that mode. It is unlikely that all the vehicles failing or passing a particular mode would have required the full mode to determine their outcome. Therefore, average test times for vehicles passing the IM240 at second 60 would be significantly less than 60 seconds. Likewise, this would be true for each mode. On-going analyses are being performed to investigate this and other alternatives such as the IM240-reversed. Finally, EPA will continue to develop alternative algorithms which are also expected to reduce the average test time for the IM240.