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The Maryland Enhanced I/M Program
2011 On-road Remote Sensing Survey

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Prepared for:

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I. Summary

The Maryland Department of the Environment (MDE) and Motor Vehicle Administration (MVA) are required by the Clean Air Act Amendments of 1990, to supplement Maryland's enhanced Inspection and Maintenance (I/M) program, known as the Vehicle Emissions Inspection Program (VEIP), with an on-road element. The on-road survey will be conducted every two years collecting measurements on 1% of the vehicles. The purpose of the survey is to determine the condition of the VEIP fleet and to evaluate the effectiveness of remote sensing devices in identifying gross polluters.

There are 4.044M registered vehicles in the I/M area. Therefore, the 1% survey was required to measure at least 40,444 vehicles.

Staff from Envirotest, the I/M contractor, conducted the 2011 survey on 25 days between May 2nd and June 13th. Emission measurements were collected from on-road vehicles at 18 sites in 18 jurisdictions (17 counties and Baltimore City). Measurements were made using an RSD-4600 unit capable of measuring hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). The remote sensing units also measure vehicle speed and acceleration to permit determination of the vehicle operating condition and capture an image of the vehicle plate for identification.

Fleet Emissions

The average emissions of the vehicles measured on-road in Maryland and registered in I/M counties were 0.08% CO, 27 ppm HC hexane and 117 ppm NOx. Results are sensitive to engine power output, which can vary from site-to-site, and the remote sensing equipment used. The RSD-4000 series of remote sensing equipment has been used since 2003. An RSD-3000 was used in 2001.

The average HC, CO and NOx emissions by model year for trucks and light passenger vehicles are shown in Figures I-1, I-2 and I-3. The trucks measured are virtually all 10,000 lbs GVWR or less. There were 67 trucks above 10,000 lbs GVWR with emissions measurements[i]

The charts show that newer model year vehicles have substantially lower emissions than older vehicles.

Impact of I/M Testing on Emissions

I/M area vehicles were divided into three groups based on their last identified I/M test result: fail or waiver, unmatched and pass. The dirtiest vehicles on-road are those that failed their most recent test or have obtained a waiver. The results for passenger vehicles and light trucks are provided in Section V.

[i]. Heavy-duty trucks are not measured by RSD without a special set-up to measure elevated exhaust from vertical stacks.

Figure I-1 On-Road Light Passenger Vehicle and Truck HC

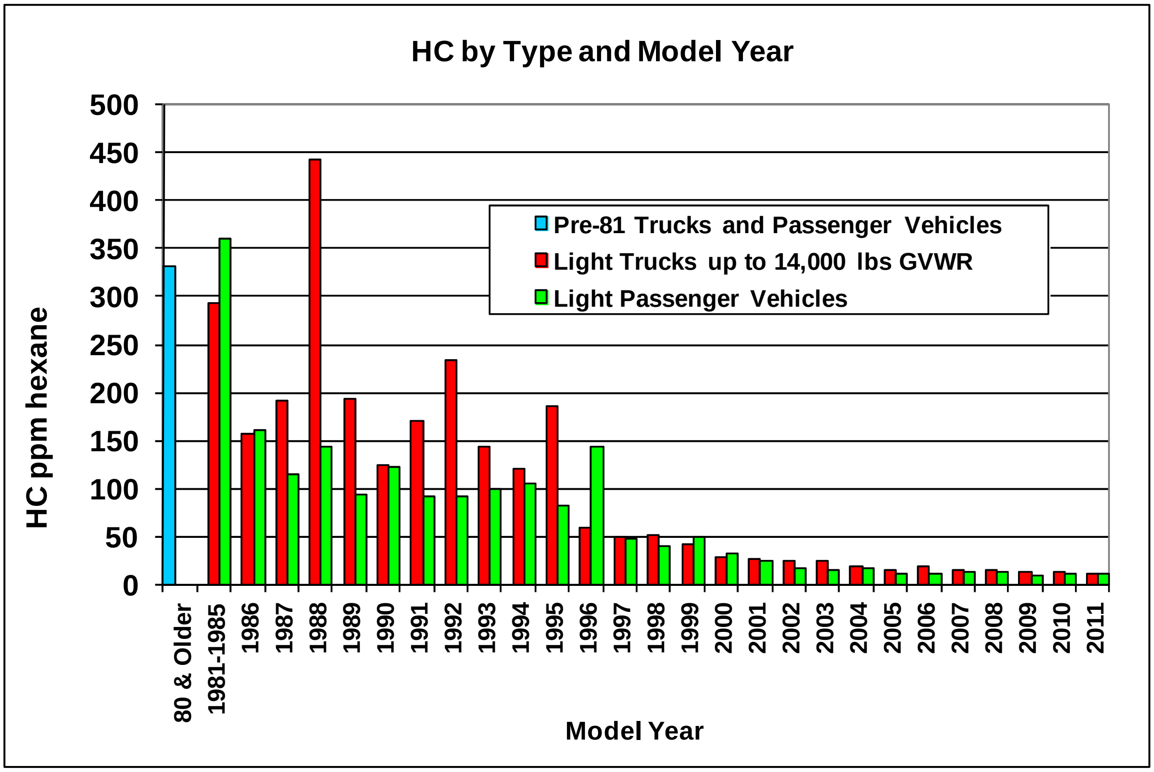


Figure I-2 On-Road Light Passenger Vehicle and Truck CO

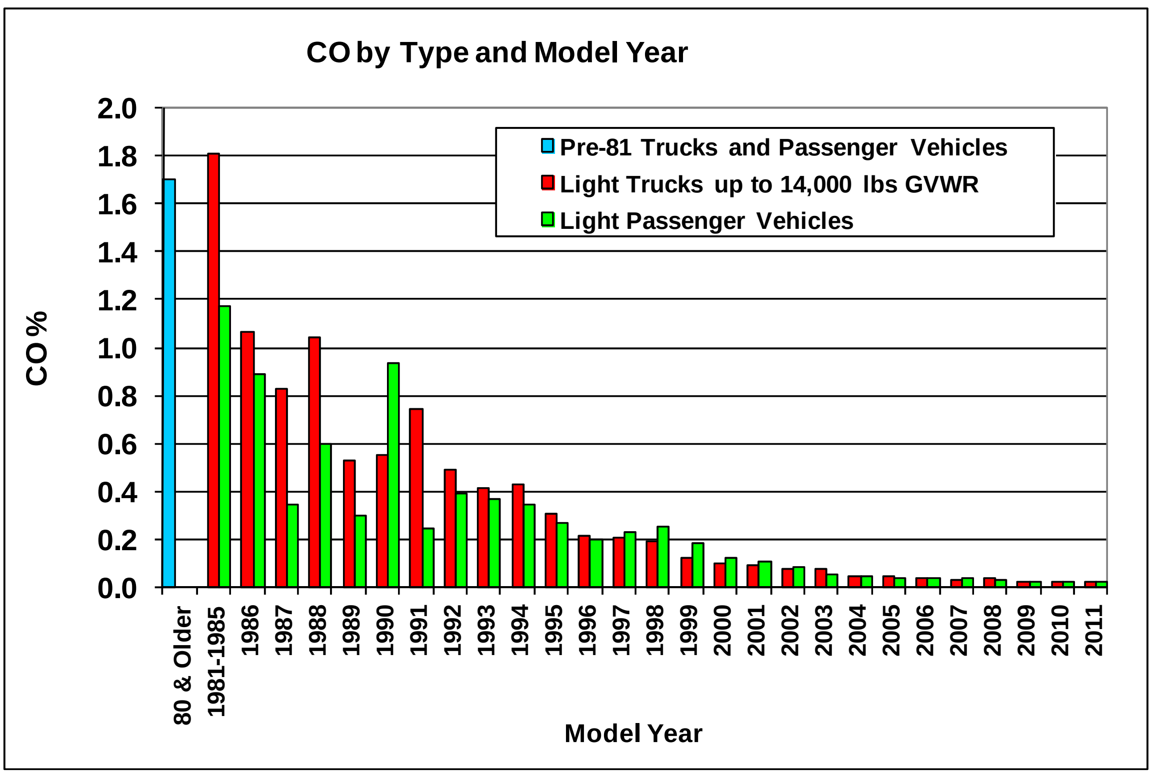
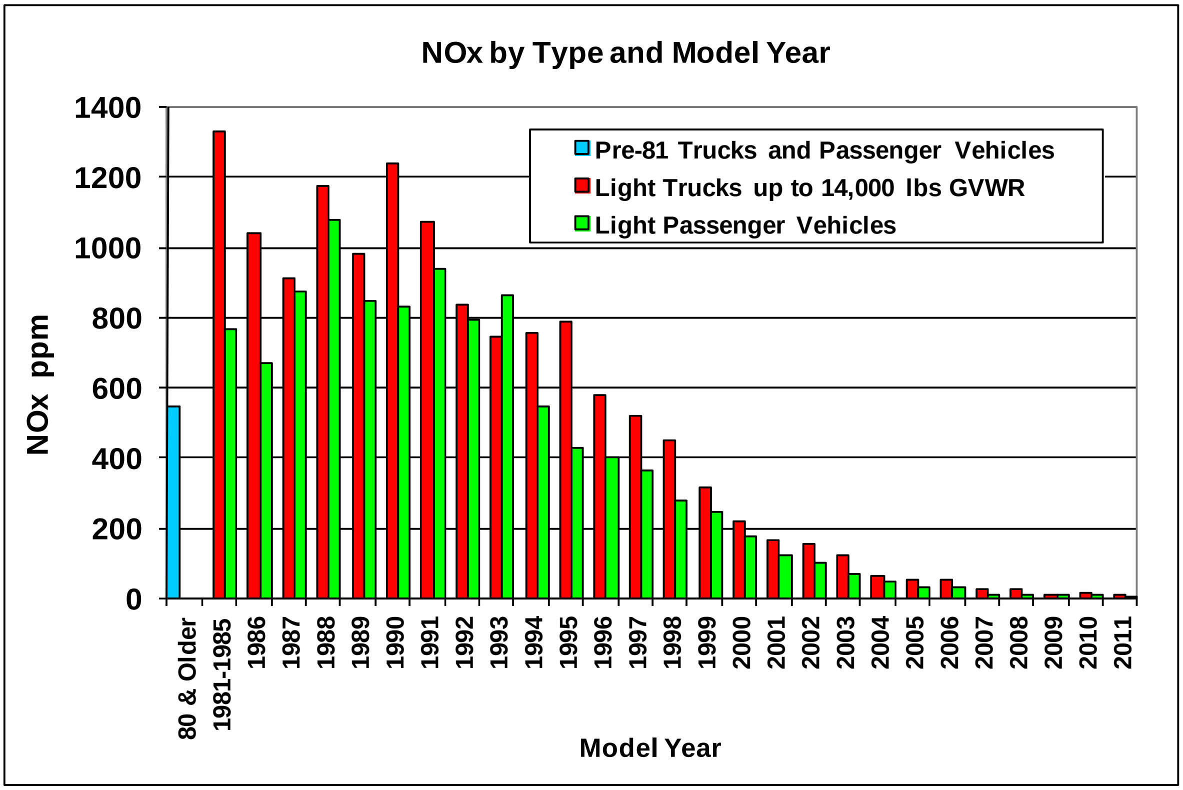


Figure I-3 On-Road Light Passenger Vehicle and Truck NOx



High Emitters

In order to be considered a high emitter in Maryland, a vehicle must have two or more readings that exceed the standards for the same pollutant on different days. If the standard is exceeded by less than the tolerance of the RSD unit, a third measurement is required for confirmation. Vehicles with out-of-State registrations were not considered in the high emitter analysis because their type and model year was unknown.

Two thousand four hundred and twelve vehicles had 2 or more measurements. Of those, 52 (2.2%) had 2 or more valid readings for a pollutant that exceeded the high emitter cutpoints on both readings. Twenty-nine of the 52 met the criteria for high emitters. Twenty-eight had 2 readings that exceeded cutpoints by more than the analyzer tolerance, and one qualified by having a third high measurement.

Twenty-four of the 52 vehicles had readings that exceeded cutpoints by less than the analyzer tolerance levels. Two vehicles had a third measurement of which one qualified, as noted above, and one did not. Details of high emitters and their identification are provided in section VI.

II. Description of the RSD Project

A. General

1. Project Requirements

The Maryland Department of the Environment (MDE) and Motor Vehicle Administration (MVA) are required by the Clean Air Act Amendments of 1990, to supplement Maryland's enhanced Inspection and Maintenance (I/M) program, known as the Vehicle Emissions Inspection Program (VEIP), with an on-road element to the program. The Clean Air Act Amendments require that a minimum of 0.5% of the eligible motor vehicle population in the enhanced program area be tested. The remote sensing surveys in Maryland are to be conducted every two years and are designed to collect at least a 1% sample on each occasion.

The Code of Federal Regulations *40 CFR, Part 51, Subpart S*, Section 51.371 covering Enhanced I/M programs defines on-road testing as testing of vehicles for conditions impacting emission of HC, CO, NOx and/or CO2 emissions on any road or roadside in the non-attainment area or the I/M program area. On road testing is required in enhanced I/M areas.

2. Contractor

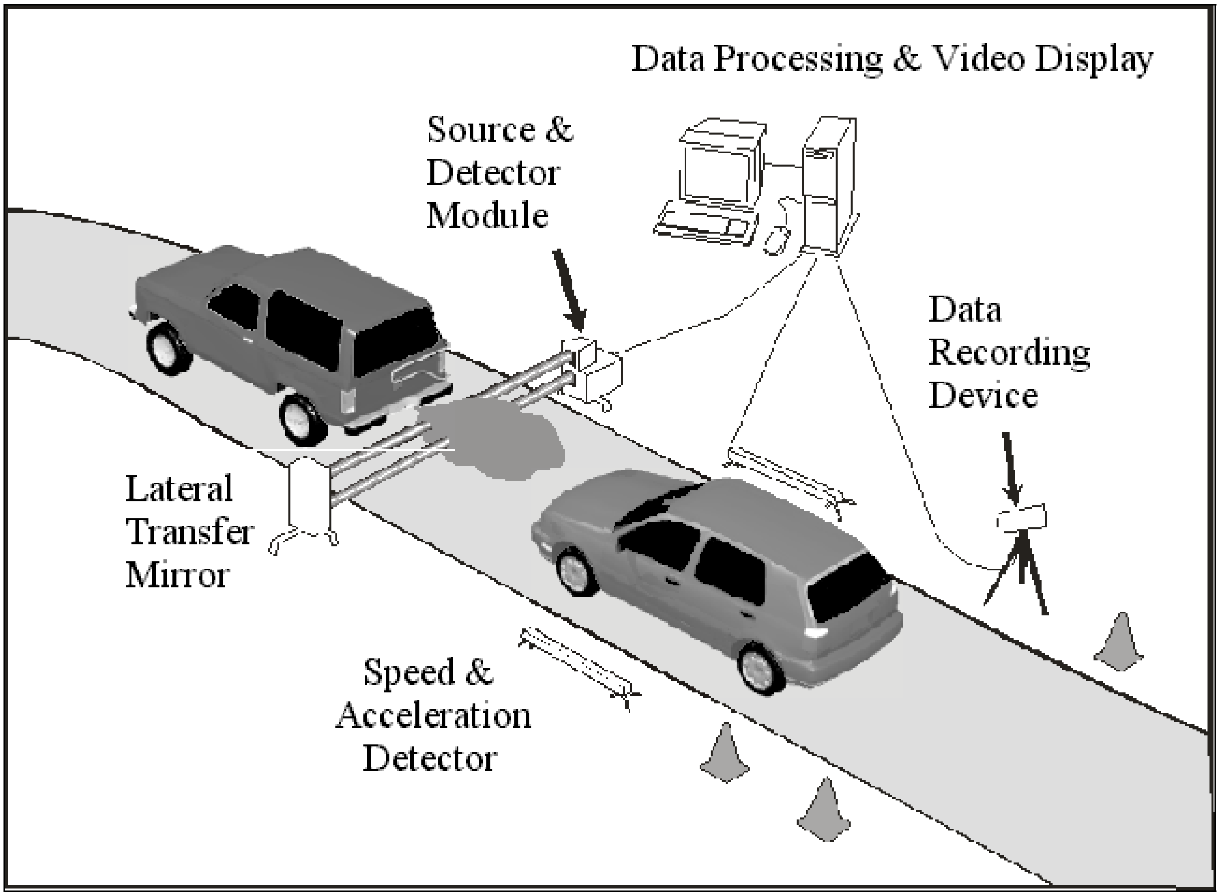
The Remote Sensing division of Envirotest has been responsible for this work. Envirotest has been developing and operating remote sensing equipment for over ten years. Envirotest uses technology derived from that originally developed at the University of Denver with whom Envirotest has a royalty agreement. Envirotest is also the operator of the centralized inspection program in Maryland.

3. Description of RSD

a) Theory of operation

The remote sensing device (RSD) is a system designed for a non-intrusive measurement of vehicle emissions. It generates and monitors a non-dispersive infrared and ultra-violet beam emitted and reflected approximately 10 to 18 inches above ground preferably across a single lane road. Gasoline, diesel, or other fossil fuel powered vehicles drive through this beam and the exhaust interferes with this transmission of the beam. Quantifying the interference enables the calculation of tailpipe concentrations of carbon monoxide (CO), hydrocarbons (HC), carbon dioxide (CO2), and nitrogen oxides (NOx). A camera simultaneously captures a digitized video image of the rear of the vehicle and its license plate. The general arrangement is illustrated in Figure II-1.

Figure II-1 On-road Remote Sensing Setup



b) Equipment

The particular equipment deployed in Maryland in the 2011 study was the RSD-4600 mobile unit also called AccuScan™. The RSD-4600 is the successor to the RSD-3000 (used in the 2001 RSD study) that was based on a technical platform developed at the University of Denver by Dr. Donald Stedman. The RSD-4600 is an improved version of the RSD-3000 with more stable and more sensitive electronic components.

Each mobile unit includes the equipment required to provide measurement of emissions as well as speed and acceleration readings and license plate recognition. Five main components comprise the RSD-4600 system:

- Infrared (IR) and ultraviolet (UV) source detector module (SDM);
- Video system;
- Control console with computer system;
- Laser based speed and acceleration measurement system;
- Specialized license plate image transcription software.

The system captures emissions readings and a camera simultaneously captures a digitized video image of the rear of the vehicle and its license plate. The video and emissions readings taken are stored directly on a removable media disk and can be used for future reference.

c) Emissions Measurements

The primary combustion gases HC, CO, NOx and CO2 are measured simultaneously along the same optic path to ensure the proper application of the combustion gas equations. To avoid interference between vehicles, the RSD unit is capable of completing the vehicle emission measurement within 0.5 second and of completing all measurements for a vehicle including emissions, speed, acceleration and plate image within one second.

The RSD unit takes multiple rapid readings of the exhaust plume for each vehicle to evaluate whether a valid measurement of a vehicle's exhaust has been achieved. At least 5 measurements of the plume with CO2 elevated above ambient by a minimum threshold are required. Up to 48 measurements may be made depending on the exhaust volume, vehicle speed, wind and other factors. The measured values are corrected to account for background concentrations of emissions.

The RSD-4600 continually measures the ambient background. As a vehicle drives by the system, the vehicle blocks the IR/UV beam. When this beam block occurs, the computer stores the current ambient background.

When the exhaust plume is observed by RSD it is already mixing with the surrounding air so that absolute concentrations of exhaust pollutant cannot be measured directly. Rather, it is the ratios of HC/CO2, CO/CO2 and NOx/CO2 combined with combustion equations that are used to calculate the pollutant concentrations.

RSD units are factory certified to meet accurate measurement of dry calibration gas. Although ambient humidity has an effect on the NOx emissions performance of vehicles, gaseous H_2O present in the atmosphere and created as a combustion product has no effect on the RSD measurement of emissions.

After every 4,000 operating hours the units are returned to the factory for preventive maintenance and re-certification. A specially modified vehicle dispenses calibration gas blends of CO2, HC, CO and NOx past the RSD unit under controlled conditions. Four separate multi-gas blends are used with ten passes per blend. A typical set of certification gases is shown in Table II-1.

Table II-1 Typical Set of Certification Gas Blends

Blend	CO %	CO2 %	HC ppm propane	NO ppm
1	0.50	15.00	500	3,000
2	1.00	14.50	3,000	2,000
3	2.75	13.00	2,000	500
4	5.00	11.50	6,000	250

The RSD tolerance for each pollutant is:

- Carbon monoxide (CO): ±0.25% CO or ±10% of the expected CO concentration {whichever is greater} for all expected concentrations less than or equal to 3.0%, and ±15% for all CO expected concentrations above 3.0% CO.
- Hydrocarbon (HC): ±150 parts-per-million (ppm) or ±15% of the expected HC concentration {whichever is greater} throughout the range of HC concentrations. In this report Hydrocarbon measurements are reported in their hexane equivalent measurement.
- Oxides of nitrogen (NO): ±250 parts-per-million (ppm) or ±15% of the expected NO concentration {whichever is greater} throughout the range of NO concentrations.

d) NO vs. NOx

The vast majority of nitric oxides emitted from the vehicle tailpipe are in the form of NO. The NO is later oxidized to NO2 and other oxides of nitrogen, which are collectively referred to as NOx. The RSD unit measures NO. To convert from NO to NOx, a factor of 1.03 is applied. For simplicity we refer to NOx measurements when reporting results. Charts in sections IV, V and VI report NOx values.

e) NOx and Humidity

Higher humidity reduces vehicle NOx emissions. When vehicles were inspected (Prior to August 2009) in the I/M program, humidity correction factors were applied to adjust NOx measurements to values that would have been achieved when the water vapor content was 75 grains per lb. For temperatures above 75 F:

Correction factor = e^(.004977*(H-75) - .004447*(T-75))

For temperatures below 75F:

Correction factor = 1/(1.0 - .0047*(H - 75.0))

Where:

H = absolute humidity in grains of water/lb dry air
T = Temperature (F)

Both of these are capped at 2.19.

The on-road NOx emissions reported in sections IV, V and VI report the NOx emissions adjusted for humidity.

Correction factors were calculated using weather information recorded by the weather station attached to the RSD van. Water vapor grains per lb were determined using the temperature, relative humidity and barometric pressure:

Saturated Vapor Pressure = $(-4.14438 \times 10^{-3} + 5.76645 \times 10^{-3} \times [\text{Temp F}] - 6.32788 \times 10^{-5} \times [\text{Temp F}]^2 + 2.12294 \times 10^{-6} \times [\text{Temp F}]^3 - 7.85415 \times 10^{-9} \times [\text{Temp F}]^4 + 6.55263 * 10^{-11} \times [\text{Temp F}]^5)*25.4$

Grains per lb = (43.478 x [Relative Humidity] x [Saturated Vapor Pressure]) / (([Barometric pressure Hg mm])-([Saturated Vapor Pressure]*[Relative Humidity]/100))

4. On-road Puff Calibrations and Puff Audits

Units are equipped with an internal calibration gas cell, which has a specific set of concentrations. As part of standard procedure, the operator must first set up the retro reflector on the far side of the road and conduct a mirror alignment check. The RSD unit sends infrared and ultraviolet beams across the roadway. These beams are reflected by the mirror and detected by the RSD unit. The RSD detectors create a voltage in response to particular infrared and ultraviolet frequencies. The presence of proper voltages across all detectors verifies that the RSD unit and the mirror are properly aligned. Second, the unit is calibrated to the calibration cell values.

The next step is to verify the unit calibration. This is referred to as a puff audit. Calibration gas is introduced into the IR/UV path. This is accomplished through a calibration gas cylinder, a stainless steel gas regulator, fittings and tubing to deliver the calibration gas to the source detector module (SDM). The operator will then introduce the calibration gas into the IR/UV path via a spray nozzle at the end of the tube. The instrument displays the readings on the screen. The RSD unit response is automatically compared to the calibration gas and required to be within specification limits.

Operators are instructed to audit approximately every hour and must audit within two hours or the records will be flagged with a CVA session status of “L” meaning lock out. The records marked with an “L” are not considered valid. Three puffs within specification are required. It may be repeated for verification at operator discretion and depending on traffic conditions. If the audits indicate the unit is operating outside the accuracy specification, then the operator is to recalibrate and re-audit.

5. Speed and Acceleration Measurements

The mobile unit is equipped with a speed and acceleration measurement system that uses extremely accurate low energy lasers to calculate the speed of the vehicle to within +/- 1 mile per hour and acceleration to within +/- 0.5 miles per hour per second at the moment exhaust is measured. The speed and acceleration measurement systems are tested at the time of system certification for functionality, do not contain any moving parts and do not require calibration.

6. Data Collected

For each vehicle the following information is collected:

- Plate number;
- HC, CO, CO2, and NO emission concentrations;
- Maximum CO2;
- Speed and acceleration;
- Temperature, barometric pressure, and humidity.

B. Overview of 1.0% Sample

1. Sample Design Criteria

The objective is to obtain the 1.0% sample from sites that will be generally representative of vehicles operating in the I/M program area.

As shown in Table II-2: 'RSD Sites', a total of 18 sites were used to collect RSD data in the state. The intent is to collect tests on a random sample that is representative of all the on-road vehicle traffic. Measurements are distributed both geographically and temporally with no one area or period of the day receiving an undue amount of testing.

2. Description of Sample Site Characteristics

Site selection is critical to obtaining RSD measurements that are representative of vehicle operation. Recommended site attributes include:

- Absence of cold start vehicle operating conditions that would cause atypically high emissions
- Sites where vehicles will generally be accelerating or driving at a steady speed uphill to avoid the highly variable tailpipe emissions that can occur under deceleration. Road grade is considered in order to preclude deceleration and assure light load on the engine.
- Absence of high engine loads that could result in atypically high emissions
- Single lane operation to unambiguously isolate individual vehicles
- High volume traffic for productivity
- Unobtrusive positioning of the remote sensing equipment to avoid motorists braking suddenly
- Multi-year stability in the traffic mix to facilitate evaluation of year-to-year trends
- Adequate median space for safe operation of the RSD equipment.

To improve the chances of multi-year stability in the traffic mix, Envirotest tries to avoid sites that are excessively influenced by temporary operations such as a large development under construction. These can change the traffic and may result in the conversion of the one-lane remote sensing site to a multiple-lane highway that is unsuitable for remote sensing.

The 2011 study had three site changes from the 2009 study. Sites TA03, WA02 and WA10 that were surveyed in 2009 were not used in 2011. Use of TA03 was discontinued as recommended in the 2009 report and approved by MDE. WA02 & WA10 were used as substitutes in 2009 because road construction had temporarily changed the traffic pattern at the preferred primary site of WA12. WA12 was available and used in 2011.

The road grade at each site is measured during the equipment set-up. The measured grade may vary slightly at each site depending on the precise positioning of the RSD equipment along the roadside. At one of the sites used in 2011, AL12, the recorded grade was greater than one degree different from that recorded in 2009. The grade at AL12 was 3.5 degrees in 2011 and 1.9

degrees in 2009. The road has since been re-paved and the operator moved 25 feet higher up the ramp for equipment safety issues discovered in 2009. This move also improved the valid rate.

The percentages of beam blocks resulting in valid measurements within the desired VSP range are reported in the rightmost column of Table II-2. Sites CL10, QA01 and HA11 had valid rates of 16%, 29% and 37% respectively. Fewer than 1,000 valid measurements per day were obtained at CL10 and QA01. If possible, alternatives should be found for CL10, QA01 and HA11.

Table II-2 RSD Sites

Site Code	Location	City	County	Degrees of Grade	Valid RSD in Desired VSP Range	% of Beam Blocks Valid
AA13	Rte 450 West St. and Jennifer Rd SB to Hwy 301 W	Annapolis	Anne Arundel	0.60	4,949	46%
AL12	From Salem St/Center St to I-68 West	Cumberland	Allegany	3.50	5,239	85%
BA04	Rte 45 SB near Phoenix Rd.	Cockeysville	Baltimore County	3.80	8,608	73%
BA20	Eastern Ave. WB to I-95 SB	Baltimore	Baltimore City	1.54	3,200	70%
CE04	Rte 222 South towards I-95	Port Deposit	Cecil	0.80	2,077	55%
CH11	Post Office Rd SB just past Industrial Park Dr	Waldorf	Charles	1.20	1,909	62%
CL10	Rte. 260 East to Rte. 4 North	Dunkirk	Calvert	-0.70	840	16%
CR01	Railroad Ave. NB Just South of Tuc Rd	Westminster	Carroll	2.30	2,751	74%
FR14	From W Patrick St to US 15 Catoctin Mtn Hwy NB	Frederick	Frederick	1.10	3,462	58%
HA11	From I-95 NB to MD 543 Riverside Pkwy	Belair	Harford	3.50	3,097	37%
HO13	From Rte. 175 EB to I-95 North	Jessup	Howard	0.30	4,123	63%
KE10	Rte. 291 Morgnec Rd. West, just pass Wash. Ave.	Chestertown	Kent	0.53	3,663	59%
MO10	Rte. 198 Spencerville Rd. East before Burtonville Dr.	Burtonville	Montgomery	0.94	8,053	42%
PG10	Rte 197 Collington Rd. North, just pass Lyle Ln.	Bowie	Prince George's	0.73	7,403	51%
QA01	Rte. 301 W on ramp from Rte. 213 S	Centreville	Queen Anne's	0.30	888	29%
SM13	Rte. 5 NB just past Rte. 246	Great Mills	St. Mary's	0.20	3,611	53%
TA01	Rte. 322 Easton Pkwy NB just past Marlboro Ave	Easton	Talbot	0.30	3,646	49%
WA12	US 11 NB, just past Massey Blvd	Hagerstown	Washington	3.40	2,681	77%
					70,200	54%

Appendix A shows the location and layout of each of the RSD sites.

3. Weather Considerations

Rain, dense fog, and wet pavement resulting in spray from tires all prevent effective operation of the remote sensing unit since the beam is partially blocked under these conditions. Similarly, cold humid conditions that cause condensation of exhaust plumes are also not productive.

As mentioned earlier, humidity corrections are made to NOx emissions measurements to account for ambient weather conditions. No corrections are required for HC or CO.

As noted earlier, some data were excluded because of suspected cold starts. These are described in section 3.B.

C. Sources of Data and Description of Elements

Data used in the analyses in this report come from three primary sources; the RSD unit measurements, the registration records maintained by the Motor Vehicle Administration, and the I/M test database maintained on the contractor host computer system.

The following description gives a summary of the main tables and data used in the analyses.

1. RSD Measurements

For each measurement record the following information is collected:

RSD unit
Date and time
License plate image
HC, CO, CO_2, and NO measurement
Speed and acceleration
Temperature, barometric pressure, and humidity
Measurement quality indicators: V-valid, X-invalid, E-invalid system exception, O-invalid other, N-NO out of range, S-suspect
Ambients[ii]

2. Data Collection Statistics

Unit
Site
Date
Start time
End time

3. RSD Sites

Site reference
Description of location
Slope of site in degrees

4. Vehicle Registration Data

The license plates of vehicles measured by RSD were matched by plate to registration records maintained by the Motor Vehicle Administration to determine the vehicle identification number (VIN) and additional vehicle information:

Vehicle identification number (VIN)
Vehicle license plate
Model year
Make
Body style

[ii] Ambient background levels of HC, CO, CO_2 and NO emissions are measured continuously and are deducted from the emissions levels measured in exhaust plumes of passing vehicles.

Gross Vehicle Weight Rating (GVWR)
City
County
Zip code

The registration vehicle body styles and GVWR values were used to classify vehicles into passenger vehicles, trucks up to 10,000 lbs GVWR and trucks over 10,000 lbs GVWR. This classification scheme is consistent with Maryland's in-use testing standards. For comparison purposes it is useful to classify vehicles using the same scheme to report on-road emissions. The Enhanced I/M test standard truck classes are:

- LDGT1: 0-6,000 lbs GVWR;
- LDGT2: 6,001-8,500 lbs GVWR;
- HDGT1: 8,501-10,000 lbs GVWR;
- HDGT2: 10,001-14,000 lbs GVWR;
- HDGT3: 14,001-26,000 lbs GWVR.

Since 99.7% of trucks were 10,000 lbs GVWR or less, trucks are treated as a single class in most sections of this report. There were 55 trucks between 10-14,000 lbs GVWR and 16 trucks greater than 14,000 lbs.

5. I/M Data

I/M test dates, times and test results were extracted from the VEIP database for VINs matching vehicles measured by RSD. The data were used to identify RSD measured vehicles that had been inspected and their most recent VEIP status prior to the RSD measurement.

D. Data Limitations

1. Remote Sensing Unit Accuracy

As described in Section II.A.4, each remote sensing device is audited periodically each day by dispensing known HC, CO, CO2 and NO blends into the optical path and comparing the measured values to the known values. If the results are outside the RSD audit tolerances, the unit is re-calibrated and another series of audit measurements are run. Passing traffic can influence individual audit measurements, in which case additional audits may be performed.

The RSD software now includes a computer verified audit (CVA) flag on each record that indicates the RSD unit had successfully completed an audit within the specified audit times. Audit time used for the study was 1-hour; however, the operator has an additional hour of grace time to perform an acceptable audit. Therefore, audit flags of "G" status insure that a successful audit has been performed within the prior two hours. Other values of the CVA flag are 'L' meaning lock out, 'S' meaning start and 'X' meaning the system is not ready to collect data. The 'S' status is used on the last successful audit record that preceded normal data collection.

2. Limitations Due to Registration Process and Data Processing

Using RSD, vehicles are first identified using the vehicle plate, which is then matched to vehicle registration data to determine the vehicle information. In a situation where upon purchase of a new vehicle, an owner may transfer the same plate from the old vehicle to the new vehicle, a data processing delay can result in incorrect identification of the vehicle measured by RSD. This delay is the time between the RSD measurement and the matching of the measurement to the registration data.

III. Summary of Data Collection

A. RSD Sample Quantity

The number of subject vehicles registered in the Enhanced I/M area was estimated to be 4.044M. Therefore, the 1% survey goal was to measure at least 40,444 vehicles.

Table III-1 summarizes the number of measurements made. In total, 129,982 measurements were taken. Out of the total measurements, 70,207 (54%) were valid records in the desired operating mode (range). A total of 7 measurements were excluded for NOx values of less than -250 ppm. The result was 70,200 (54%) valid records in the desired VSP range. Further screening of the valid records excluded 8,512 records without readable plate images. The net result was 61,688 (47% of total measurements) valid records with readable plates.

The valid records with readable plates were then screened for MD plates only. The result was 54,671 valid MD records. These records were then matched to the MVA registration database. The matching resulted in 52,965 records, or a match of 97% of all valid MD records. Of these, 48,104 were collected in the Enhanced I/M area and the 1% survey goal was therefore satisfied.

Table III-1 Collection Summary

Item	Quantity	%
Beam blocks	129,982	
RSD valid HC, CO, NOx, Speed & Acceleration		
and in desired operating mode (VSP)	70,207	54%
Additional screening:		
CVS status not equal "G"	-	0.0%
NOx values less than -250 ppm	7	0.0%
Possible cold start	-	0%
Valid and in desired VSP range after screening	70,200	54%
Valid with readable plate	61,688	47%
Of which:		
Out of State License Plate	7,017	11%
Maryland License Plate	54,671	89%
Of which:		
Matched to MVA Registration	52,965	97%

Table III-2 shows the measurements collected by county with valid HC, CO, NO, speed, acceleration and a plate. The statistics include multiple results for vehicles measured more than once. Table III-3 shows for each county:

- The number of vehicles registered in the county;
- The number of valid on-road measurements collected in the county;
- On-road measurements collected in the county as a percentage of registrations;

- The number of on-road measurements matching vehicles registered in the county, and
- The number of on-road measurements matching vehicles registered in the county as a percentage of registrations.

In the last two columns, on-road measurements that were matched to vehicles registered in the county may have been collected in any county.

The 1% collection goal was achieved for the I/M area. The number of registrations matched in I/M counties was 1.1% of registrations.

Table III-2 RSD Measurements Collected by County

RSD County	Beam Blocks	Valid: Gases, Speed & Accel & in VSP Range	Valid w Readable MD Plate	Valid w Out Of State Plate	Total Complete Records	%	Valid w MD Plate Matched to Registration	Plate Match %
Allegany	6,160	5,239	3,436	1,257	4,693	76%	3313	96%
Anne Arundel	10,667	4,949	3,932	410	4,342	41%	3800	97%
Baltimore City	4,587	3,200	2,440	201	2,641	58%	2365	97%
Baltimore County	11,738	8,608	7,153	806	7,959	68%	6979	98%
Calvert	5,101	840	641	93	734	14%	621	97%
Carroll	3,697	2,751	2,163	279	2,442	66%	2095	97%
Cecil	3,764	2,077	1,487	382	1,869	50%	1440	97%
Charles	3,067	1,909	1,624	123	1,747	57%	1556	96%
Frederick	5,967	3,462	2,591	338	2,929	49%	2516	97%
Harford	8,387	3,097	2,400	323	2,723	32%	2324	97%
Howard	6,494	4,123	3,392	389	3,781	58%	3292	97%
Kent	6,173	3,663	2,604	391	2,995	49%	2503	96%
Montgomery	18,993	8,053	6,621	483	7,104	37%	6450	97%
Prince George's	14,433	7,403	6,166	563	6,729	47%	5980	97%
Queen Anne's	3,016	888	643	77	720	24%	623	97%
St. Mary's	6,870	3,611	2,579	232	2,811	41%	2484	96%
Talbot	7,371	3,646	2,846	239	3,085	42%	2723	96%
Washington	3,497	2,681	1,953	431	2,384	68%	1901	97%
Total	129,982	70,200	54,671	7,017	61,688	47%	52,965	97%

Table III-3 On-road Measurements by County as % of Registrations

County	2010 Registered Vehicles	Valid On-Road Measurements Collected	Collected / Registered	Matches to a Registration in This County (Collected Anywhere)	Matched / Registered
Subject to I/M:					
Anne Arundel	489,199	4,342	0.9%	4,986	1.0%
Baltimore County	636,814	7,959	1.2%	6,928	1.1%
Baltimore City	284,259	2,641	0.9%	3,485	1.2%
Calvert	82,085	734	0.9%	821	1.0%
Carroll	160,750	2,442	1.5%	2,137	1.3%
Cecil	83,336	1,869	2.2%	1,340	1.6%
Charles	126,611	1,747	1.4%	1,452	1.1%
Frederick	208,894	2,929	1.4%	2,407	1.2%
Harford	219,180	2,723	1.2%	2,268	1.0%
Howard	240,716	3,781	1.6%	2,616	1.1%
Montgomery	728,813	7,104	1.0%	4,969	0.7%
Prince George's	615,824	6,729	1.1%	6,023	1.0%
Queen Anne's	43,855	720	1.6%	1,249	2.8%
Washington	124,032	2,384	1.9%	2,133	1.7%
Subtotal I/M Area	4,044,368	48,104	1.2%	42,814	1.1%
Non-I/M:					
Allegany	58,368	4,693	8.0%	3,040	5.2%
Caroline	31,121	n/a	n/a	405	1.3%
Kent	19,300	2,995	15.5%	1,971	10.2%
St. Mary's	92,116	2,811	3.1%	2,392	2.6%
Talbot	36,205	3,085	8.5%	1,666	4.6%
Other	202,567	n/a	n/a	677	0.3%
Total	4,484,045	61,688	1.4%	52,965	1.2%

B. RSD Sample Description

1. Measurements and Conditions by Site and Time of Day

Table III-4 'Measurements by Site and Time of Day' shows the valid measurements made per hour on each day by each unit and the site measured. The column header shows the hour in which the measurements were made. The hourly counts are for measurements with valid emission, speed, acceleration and a visible plate. Most measurements were made between 6:00 a.m. and 5:00 p.m.

Similarly, Tables III-5 to III-9 show the average hourly speed, acceleration, CO, HC and NO measured each day by each unit.

Site HA11 with a grade of 3.5 degrees showed small negative accelerations for much of the day. At sites with positive grade, vehicles may have positive specific power even though they are decelerating.

At FR14 on 5/18 between 1:00pm and 2:00pm, the HC average was 1095 ppm. There were only ten vehicle measurements in the period including one 1995 model with HC emissions over 10,000ppm and NO emissions over 1400ppm. This vehicle caused the high average HC value.

Table III-10 shows the percentage of 2006 and newer models with HC greater than 150 ppm HC hexane[iii]. Table III-11 shows the average temperature measured at the RSD van. Few new model vehicles are expected to have high emissions once they have warmed up. If more than 5% of these vehicles have high emissions, it is possible there were an excessive number of cold starts or cold temperature effects.

Hourly average HC, the percentages of new models with HC greater than 150 ppm and the hourly temperatures were reviewed. In four instances the rate was higher than 5% with the highest being 6.2%. Temperatures were not cold, however, and the rates over 5% all occurred on different days.

[iii] The percentages of 2006 and newer models with HC greater than 150 ppm HC hexane are shown in Table III-10 only for hours in which more than twenty RSD records were available for these models.

Table III-4 Valid Measurements with Plate by Site and Time of Day

			Hourly Valid Measurements with Plates												
Date	**Van**	**Site**	**06 & earlier**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18 & later**
5/2/2011	__07064619	KE10	64	77	93	94	82	78	83	79	76	111	89	69	83
5/3/2011	__07064619	KE10							103	110	93	126	123	71	113
5/4/2011	__07064619	TA01								84	161	196	207	175	244
5/5/2011	__07064619	TA01	92	125	114	138	152	149	169	190	177	163	190	214	145
5/6/2011	__07064619	KE10	93	81	110	72	84	84	106	81	104	128	128	107	
5/9/2011	__07064619	QA01	95	142	90	79	53	79	56	40	59	27			
5/10/2011	__07064619	SM13	133	222	215	196	194	205	238	216	273	437	482		
5/11/2011	__07064619	CH11	29	84	138	157	192	210	257	221	212	246	1		
5/12/2011	__07064619	CL10	178	143	90	57	37	33	38	34	46	40	37	1	
5/16/2011	__07064619	AL12	195	400	320	296	292	300	374	362	408	504	538	406	298
5/17/2011	__07064619	WA12		7	112	217	211	188	231	322	340	443	313		
5/18/2011	__07064619	FR14		168	387	340	342	250	2	10	355	355	365	348	7
5/19/2011	__07064619	CR01	152	266	231	213	228	217	184	241	265	377	68		
5/23/2011	__07064619	HA11	340	276	220	80	109	111	117	125	221	327	499	297	1
5/24/2011	__07064619	HO13	307	510	374	44	317	296	390	457	513	568	5		
5/25/2011	__07064619	BA04										21	770	871	
5/26/2011	__07064619	BA20		302	218	177	145	151	151	147	146	176	171	156	
5/31/2011	__07064619	CE04	643	531	325	238	132								
6/1/2011	__07064619	MO10	311	422	333	322	218	217	255	157	363	436	453	475	
6/2/2011	__07064619	PG10	310	535	382	414	385	411	396	341	467	480	375		
6/3/2011	__07064619	BA04	321	520	521	413	337	490	604	429	369	445	743	814	291
6/6/2011	__07064619	AA13	206	294	250	212	302	261	360	338	334	368	418	436	563
6/8/2011	__07064619	MO10	49	235	447	298	352	237	253	276	242	322	431		
6/9/2011	__07064619	BA20	278	229	157	37									
6/13/2011	__07064619	PG10	270	461	483	297	284	343	95						
Total			4,066	6,030	5,610	4,391	4,448	4,310	4,462	4,260	5,224	6,296	6,406	4,440	1,745

Table III-5 Average Speed by Site and Time of Day

Mean Hourly Speed MPH															
Date	**Unit**	**Site**	**06 & earlier**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18 & later**
5/2/2011	__07064619	KE10	28	28	29	27	27	29	28	28	28	28	28	29	29
5/3/2011	__07064619	KE10							29	29	29	28	29	30	29
5/4/2011	__07064619	TA01								35	35	36	36	35	36
5/5/2011	__07064619	TA01	37	35	35	34	34	35	34	33	35	33	35	34	36
5/6/2011	__07064619	KE10	27	28	29	27	27	28	27	27	28	27	27	28	
5/9/2011	__07064619	QA01	48	47	46	46	46	44	46	45	44	46			
5/10/2011	__07064619	SM13	28	28	29	28	29	27	28	28	28	20	16		
5/11/2011	__07064619	CH11	32	29	29	29	29	30	28	29	30	29	28		
5/12/2011	__07064619	CL10	46	41	45	44	42	43	41	44	42	42	42	49	
5/16/2011	__07064619	AL12	25	25	25	25	24	25	24	24	25	25	25	25	24
5/17/2011	__07064619	WA12		25	26	28	27	23	22	25	25	25	25		
5/18/2011	__07064619	FR14		27	29	29	29	28	23	24	28	29	29	27	30
5/19/2011	__07064619	CR01	25	24	24	24	24	24	23	24	25	25	23		
5/23/2011	__07064619	HA11	37	37	37	43	39	40	41	42	41	40	34	40	35
5/24/2011	__07064619	HO13	33	31	32	30	33	32	32	32	31	31	23		
5/25/2011	__07064619	BA04										31	30	29	
5/26/2011	__07064619	BA20		31	32	32	31	31	32	31	31	31	32	33	
5/31/2011	__07064619	CE04	32	31	34	34	34								
6/1/2011	__07064619	MO10	34	30	33	30	34	33	32	32	33	28	31	28	
6/2/2011	__07064619	PG10	34	29	30	33	32	33	31	31	26	25	17		
6/3/2011	__07064619	BA04	36	34	31	33	34	31	31	33	33	33	31	29	34
6/6/2011	__07064619	AA13	29	29	29	29	30	29	29	29	29	26	27	27	28
6/8/2011	__07064619	MO10	37	35	28	30	27	32	33	31	31	32	28		
6/9/2011	__07064619	BA20	31	31	30	31									
6/13/2011	__07064619	PG10	32	30	30	32	31	31	31						

Table III-6 Average Acceleration by Site and Time of Day

Mean Hourly Acceleration MPH/s																
Date	**Unit**	**Site**	**06 & earlier**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18 & later**
5/2/2011	__07064619	KE10	0.5	0.6	0.6	0.7	0.6	0.7	0.8	0.7	0.6	0.7	0.6	0.9	0.6
5/3/2011	__07064619	KE10							0.6	0.5	0.5	0.6	0.5	0.5	0.5
5/4/2011	__07064619	TA01								1.0	1.0	1.0	1.0	1.0	1.0
5/5/2011	__07064619	TA01	0.8	0.9	0.9	1.0	1.0	0.9	1.1	1.1	0.9	1.0	1.0	1.0	1.1
5/6/2011	__07064619	KE10	0.4	0.3	0.4	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.5	
5/9/2011	__07064619	QA01	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.5	0.5			
5/10/2011	__07064619	SM13	1.2	1.3	1.3	1.4	1.3	1.4	1.3	1.2	1.2	1.5	1.6		
5/11/2011	__07064619	CH11	0.5	0.5	0.7	0.6	0.8	0.8	0.9	0.8	0.7	0.7	-0.4		
5/12/2011	__07064619	CL10	0.9	1.3	1.0	1.0	1.1	1.2	1.2	1.0	1.0	1.1	1.1	0.4	
5/16/2011	__07064619	AL12	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.9	0.8	0.8	0.7	0.8
5/17/2011	__07064619	WA12		0.0	0.5	0.4	0.5	0.9	0.9	0.7	0.7	0.7	0.7		
5/18/2011	__07064619	FR14		0.9	0.8	0.8	0.9	0.9	0.5	1.1	0.9	0.9	0.9	1.0	1.3
5/19/2011	__07064619	CR01	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5		
5/23/2011	__07064619	HA11	-0.1	-0.2	-0.1	-0.4	-0.3	-0.3	-0.4	-0.4	-0.4	-0.2	0.1	-0.2	-0.1
5/24/2011	__07064619	HO13	1.3	1.4	1.4	1.2	1.4	1.4	1.5	1.4	1.4	1.4	1.5		
5/25/2011	__07064619	BA04										0.4	0.4	0.5	
5/26/2011	__07064619	BA20		0.9	1.0	0.9	1.1	1.0	0.9	0.9	0.8	0.9	0.9	0.9	
5/31/2011	__07064619	CE04	1.0	1.0	0.8	0.9	0.8								
6/1/2011	__07064619	MO10	0.6	0.8	0.7	0.9	0.6	0.7	0.8	0.8	0.7	0.9	0.9	1.0	
6/2/2011	__07064619	PG10	0.6	0.9	1.0	0.8	0.7	0.7	0.8	0.8	1.0	1.0	1.3		
6/3/2011	__07064619	BA04	0.1	0.2	0.4	0.3	0.2	0.4	0.3	0.2	0.1	0.0	0.3	0.5	0.1
6/6/2011	__07064619	AA13	0.8	0.8	0.8	0.9	0.8	0.9	0.8	0.7	0.7	0.9	0.8	0.8	0.8
6/8/2011	__07064619	MO10	0.5	0.5	0.9	0.8	0.9	0.8	0.6	0.8	0.8	0.6	0.9		
6/9/2011	__07064619	BA20	1.0	1.1	1.1	1.0									
6/13/2011	__07064619	PG10	0.8	0.9	0.9	0.9	0.9	0.9	0.9						

Table III-7 Average CO% by Site and Time of Day

			Mean Hourly CO %											
Date	**Unit**	**Site**	**06 & earlier**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18 & later**
5/2/2011	__07064619	KE10	0.1	0.2	0.0	0.1	0.0	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1
5/3/2011	__07064619	KE10							0.1	0.1	0.2	0.0	0.1	0.1	0.1
5/4/2011	__07064619	TA01								0.1	0.1	0.2	0.0	0.1	0.1
5/5/2011	__07064619	TA01	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5/6/2011	__07064619	KE10	0.1	0.2	0.0	0.1	0.1	0.4	0.0	0.2	0.1	0.1	0.0	0.0	
5/9/2011	__07064619	QA01	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0			
5/10/2011	__07064619	SM13	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1		
5/11/2011	__07064619	CH11	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1		
5/12/2011	__07064619	CL10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	
5/16/2011	__07064619	AL12	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5/17/2011	__07064619	WA12		0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
5/18/2011	__07064619	FR14		0.1	0.1	0.0	0.0	0.1	0.0	0.4	0.1	0.1	0.1	0.1	0.0
5/19/2011	__07064619	CR01	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1		
5/23/2011	__07064619	HA11	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
5/24/2011	__07064619	HO13	0.1	0.1	0.0	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.0		
5/25/2011	__07064619	BA04										0.0	0.1	0.0	
5/26/2011	__07064619	BA20		0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	
5/31/2011	__07064619	CE04	0.1	0.1	0.1	0.0	0.1								
6/1/2011	__07064619	MO10	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.0	
6/2/2011	__07064619	PG10	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1		
6/3/2011	__07064619	BA04	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
6/6/2011	__07064619	AA13	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2
6/8/2011	__07064619	MO10	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1		
6/9/2011	__07064619	BA20	0.2	0.1	0.2	0.3									
6/13/2011	__07064619	PG10	0.1	0.0	0.0	0.0	0.1	0.0	0.0						

Table III-8 Average HC ppm hexane by Site and Time of Day

			Mean Hourly HC ppm hexane												
Date	**Unit**	**Site**	**06 & earlier**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18 & later**
5/2/2011	__07064619	KE10	38	61	29	53	89	46	48	71	40	35	39	32	36
5/3/2011	__07064619	KE10							24	43	55	46	33	21	63
5/4/2011	__07064619	TA01								58	27	44	17	21	38
5/5/2011	__07064619	TA01	54	20	19	25	51	33	46	38	43	36	25	37	24
5/6/2011	__07064619	KE10	59	47	38	37	51	75	55	67	90	63	44	43	
5/9/2011	__07064619	QA01	19	14	23	29	34	45	48	51	54	50			
5/10/2011	__07064619	SM13	59	41	63	48	89	67	70	63	47	46	66		
5/11/2011	__07064619	CH11	10	27	27	74	34	46	64	47	43	51	4		
5/12/2011	__07064619	CL10	35	10	3	9	19	18	21	29	23	47	31	7	
5/16/2011	__07064619	AL12	60	55	64	68	67	71	36	33	26	28	31	20	24
5/17/2011	__07064619	WA12		21	28	24	29	24	41	33	20	24	18		
5/18/2011	__07064619	FR14		7	16	26	42	21	5	1095	25	24	48	28	19
5/19/2011	__07064619	CR01	51	58	43	45	36	40	39	35	51	35	45		
5/23/2011	__07064619	HA11	29	37	14	14	17	13	32	25	39	31	32	25	11
5/24/2011	__07064619	HO13	8	5	6	23	6	28	11	15	10	12	4		
5/25/2011	__07064619	BA04										11	20	14	
5/26/2011	__07064619	BA20		14	33	19	23	33	21	16	19	22	15	24	
5/31/2011	__07064619	CE04	44	44	31	29	34								
6/1/2011	__07064619	MO10	27	21	17	29	17	29	29	39	28	33	30	26	
6/2/2011	__07064619	PG10	22	25	22	21	18	22	25	28	39	32	44		
6/3/2011	__07064619	BA04	18	15	26	27	45	19	17	23	18	15	15	12	12
6/6/2011	__07064619	AA13	26	26	29	36	28	41	33	41	41	40	21	25	32
6/8/2011	__07064619	MO10	-2	2	15	21	28	21	39	25	36	131	25		
6/9/2011	__07064619	BA20	31	23	24	43									
6/13/2011	__07064619	PG10	14	18	12	16	15	13	12						

Table III-9 Average NO ppm by Site and Time of Day

Mean Hourly NO ppm															
Date	**Unit**	**Site**	**06 & earlier**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18 & later**
5/2/2011	__07064619	KE10	152	81	83	90	156	160	178	93	60	93	123	74	115
5/3/2011	__07064619	KE10							145	204	120	179	221	132	114
5/4/2011	__07064619	TA01								247	190	274	212	212	183
5/5/2011	__07064619	TA01	212	123	245	195	237	195	257	207	322	305	191	279	247
5/6/2011	__07064619	KE10	205	175	158	115	128	225	152	185	212	208	169	128	
5/9/2011	__07064619	QA01	120	82	110	83	151	124	76	112	197	146			
5/10/2011	__07064619	SM13	213	151	223	182	258	224	253	218	227	155	149		
5/11/2011	__07064619	CH11	35	126	141	259	292	308	228	203	232	304	-14		
5/12/2011	__07064619	CL10	162	195	148	201	147	384	192	123	179	179	221	19	
5/16/2011	__07064619	AL12	306	208	251	277	237	212	202	228	256	215	244	198	231
5/17/2011	__07064619	WA12		492	210	211	164	176	208	237	209	208	205		
5/18/2011	__07064619	FR14		66	107	120	120	144	26	537	159	106	123	152	102
5/19/2011	__07064619	CR01	146	167	177	156	175	156	166	189	188	187	226		
5/23/2011	__07064619	HA11	105	99	71	66	55	75	81	98	90	97	65	67	-4
5/24/2011	__07064619	HO13	178	97	108	125	96	95	116	157	128	132	15		
5/25/2011	__07064619	BA04										25	116	99	
5/26/2011	__07064619	BA20		146	182	195	216	225	180	157	150	153	179	176	
5/31/2011	__07064619	CE04	107	107	108	123	126								
6/1/2011	__07064619	MO10	73	107	68	72	88	135	116	89	90	74	92	81	
6/2/2011	__07064619	PG10	134	105	85	96	106	114	135	99	116	95	99		
6/3/2011	__07064619	BA04	149	141	110	153	144	120	112	126	136	88	134	91	108
6/6/2011	__07064619	AA13	87	109	141	154	126	182	148	130	89	144	92	112	132
6/8/2011	__07064619	MO10	193	81	83	84	78	120	103	134	100	134	94		
6/9/2011	__07064619	BA20	228	162	202	174									
6/13/2011	__07064619	PG10	91	100	97	74	105	104	91						

Table III-10 Average % of New Models with HC Greater than 150ppm Hexane

Hourly percent of MY 2006 and newer with HC GT 150 ppm hexane															
Date	**Unit**	**site**	**06 & earlier**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18 & later**
5/2/2011	__07064619	KE10	-	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	-
5/3/2011	__07064619	KE10	-	-	-	-	-	-	0.0%	3.4%	-	0.0%	0.0%	-	0.0%
5/4/2011	__07064619	TA01	-	-	-	-	-	-	-	4.5%	2.2%	0.0%	1.3%	0.0%	0.0%
5/5/2011	__07064619	TA01	0.0%	0.0%	2.2%	0.0%	0.0%	3.7%	2.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%
5/6/2011	__07064619	KE10	4.3%	0.0%	0.0%	0.0%	0.0%	-	5.4%	-	0.0%	0.0%	0.0%	2.6%	-
5/9/2011	__07064619	QA01	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	-	-	-	-	-
5/10/2011	__07064619	SM13	0.0%	1.4%	1.5%	1.9%	1.7%	0.0%	6.2%	0.0%	3.4%	0.0%	0.5%	-	-
5/11/2011	__07064619	CH11	-	0.0%	0.0%	2.1%	0.0%	2.9%	1.2%	2.7%	1.8%	0.0%	-	-	-
5/12/2011	__07064619	CL10	0.0%	0.0%	0.0%	0.0%	-	-	-	-	-	-	-	-	-
5/16/2011	__07064619	AL12	0.0%	0.0%	0.0%	0.0%	1.4%	5.2%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5/17/2011	__07064619	WA12	-	-	3.0%	0.0%	0.0%	0.0%	1.6%	2.4%	0.0%	1.6%	0.0%	-	-
5/18/2011	__07064619	FR14	-	0.0%	0.7%	0.0%	0.0%	0.0%	-	-	0.8%	0.0%	0.0%	0.0%	-
5/19/2011	__07064619	CR01	1.9%	5.4%	4.0%	1.9%	0.0%	4.3%	1.7%	0.0%	0.0%	0.8%	-	-	-
5/23/2011	__07064619	HA11	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%	0.4%	0.0%	-
5/24/2011	__07064619	HO13	0.0%	0.0%	0.0%	-	0.0%	0.8%	0.0%	0.5%	0.0%	0.0%	-	-	-
5/25/2011	__07064619	BA04	-	-	-	-	-	-	-	-	-	-	0.6%	0.5%	-
5/26/2011	__07064619	BA20	-	0.8%	1.3%	0.0%	0.0%	0.0%	3.3%	0.0%	0.0%	0.0%	0.0%	1.7%	-
5/31/2011	__07064619	CE04	1.7%	0.0%	2.6%	1.3%	0.0%	-	-	-	-	-	-	-	-
6/1/2011	__07064619	MO10	0.0%	0.0%	0.7%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.6%	-
6/2/2011	__07064619	PG10	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	0.0%	0.6%	0.0%	2.5%	-	-
6/3/2011	__07064619	BA04	0.8%	0.0%	0.4%	0.0%	0.0%	1.0%	0.4%	0.0%	0.7%	0.5%	0.3%	0.0%	0.8%
6/6/2011	__07064619	AA13	0.0%	0.0%	0.0%	1.1%	0.0%	1.0%	0.7%	0.0%	0.7%	0.7%	0.0%	0.0%	0.5%
6/8/2011	__07064619	MO10	-	0.0%	0.0%	0.8%	0.8%	1.1%	0.0%	0.0%	0.0%	0.9%	0.0%	-	-
6/9/2011	__07064619	BA20	1.1%	1.0%	0.0%	-	-	-	-	-	-	-	-	-	-
6/13/2011	__07064619	PG10	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	-	-	-	-	-	-

III-11 Average Hourly Temperature

Mean Hourly Temperature															
Date	**Unit**	**Site**	**06 & earlier**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18 & later**
5/2/2011	__07064619	KE10	18	19	19	20	24	27	28	29	29	30	30	29	29
5/3/2011	__07064619	KE10							31	33	33	34	34	35	34
5/4/2011	__07064619	TA01								12	13	15	17	18	19
5/5/2011	__07064619	TA01	11	11	12	13	15	16	17	19	19	20	21	21	21
5/6/2011	__07064619	KE10	17	22	27	27	27	27	29	29	30	31	30	29	
5/9/2011	__07064619	QA01	20	24	28	32	33	34	35	34	34	34			
5/10/2011	__07064619	SM13	15	18	22	26	27	28	29	30	31	31	32		
5/11/2011	__07064619	CH11	18	18	19	20	24	25	26	27	27	27	27		
5/12/2011	__07064619	CL10	16	16	18	22	24	25	27	29	31	33	33		
5/16/2011	__07064619	AL12	20	22	21	24	25	27	30	29	30	29	29	27	24
5/17/2011	__07064619	WA12		19	20	20	20	20	20	21	22	23	24		
5/18/2011	__07064619	FR14		22	24	26	26	27		23	25	27	27	27	29
5/19/2011	__07064619	CR01	19	20	20	21	21	20	20	22	23	24	25		
5/23/2011	__07064619	HA11	23	24	24	25	28	31	33	34	34	34	34	34	32
5/24/2011	__07064619	HO13	27	27	28	27	28	30	31	32	33	34	34		
5/25/2011	__07064619	BA04										34	36	37	
5/26/2011	__07064619	BA20		29	30	32	35	36	36	38	39	40	40	38	
5/31/2011	__07064619	CE04	28	30	35	37	41								
6/1/2011	__07064619	MO10	27	28	31	34	37	38	40	40	40	40	40	39	
6/2/2011	__07064619	PG10	23	23	25	26	27	28	29	31	34	35	34		
6/3/2011	__07064619	BA04	19	20	25	29	30	30	30	29	31	33	33	33	33
6/6/2011	__07064619	AA13	26	27	30	33	35	34	34	33	33	34	31	32	31
6/8/2011	__07064619	MO10	28	28	26	32	34	35	36	38	38	40	41		
6/9/2011	__07064619	BA20	31	32	34	36									
6/13/2011	__07064619	PG10	21	21	22	23	24	25	26						

2. *Identification and Treatment of Outliers*

Measurements outside expected measurement ranges were flagged invalid as indicated below:

- HC less than minus 150 ppm hexane or greater than 50,000 ppm hexane: 0 records
- CO less than minus 0.25% or greater than 20%: 0 records
- NO less than minus 250 ppm or greater than 20,000 ppm: 7 records

Daily mean values of HC, CO and NO were calculated for 2006 and newer vehicles after removal of the outlying measurements. The results are plotted in Figures III-1 through III-3.

Figure III-1 Daily Mean HC for 2006 and Newer Vehicles

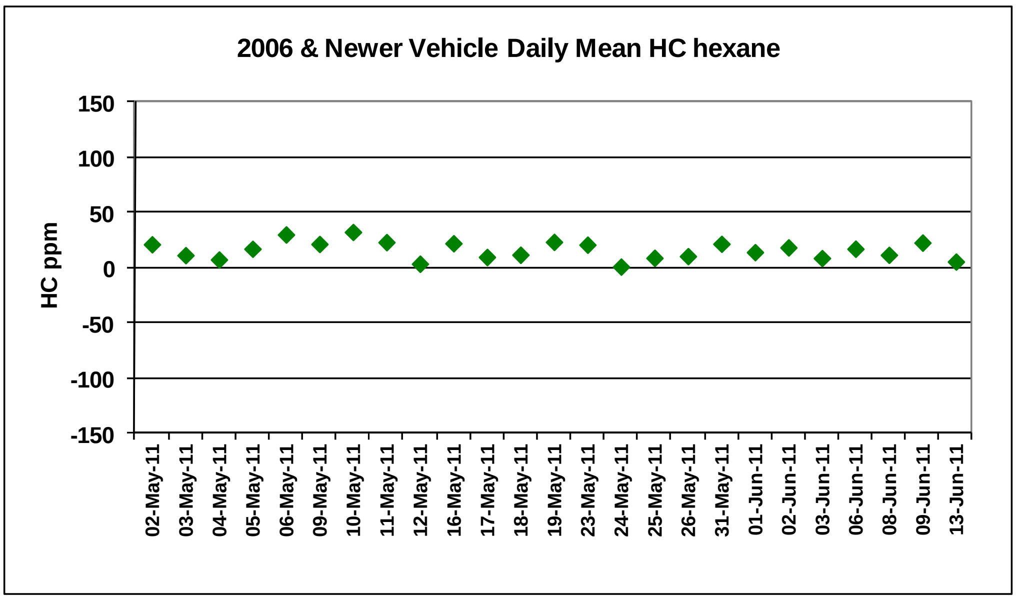


Figure III-2 Daily Mean CO for 2006 and Newer Vehicles

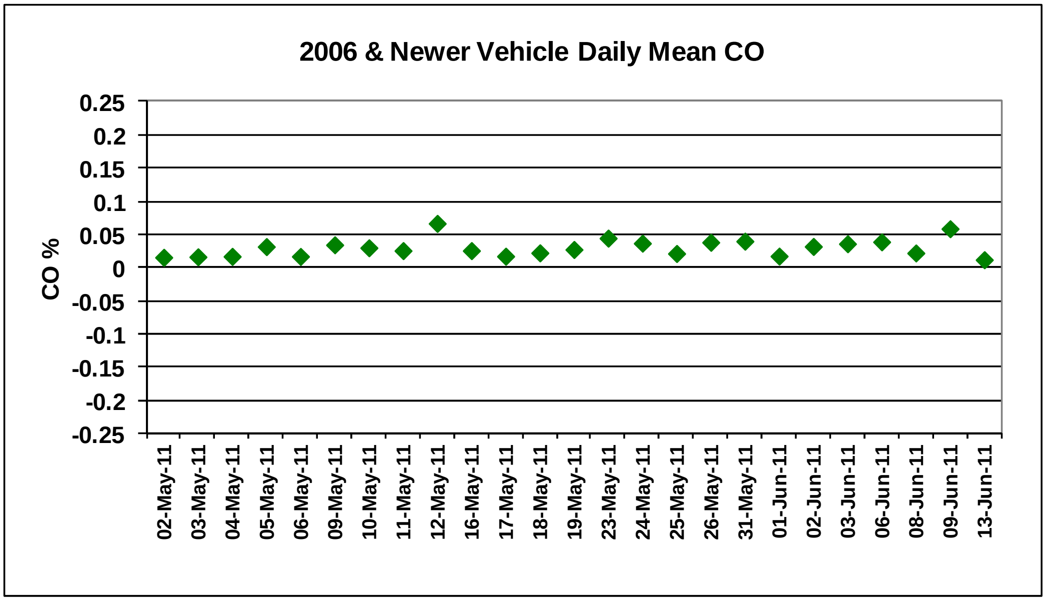
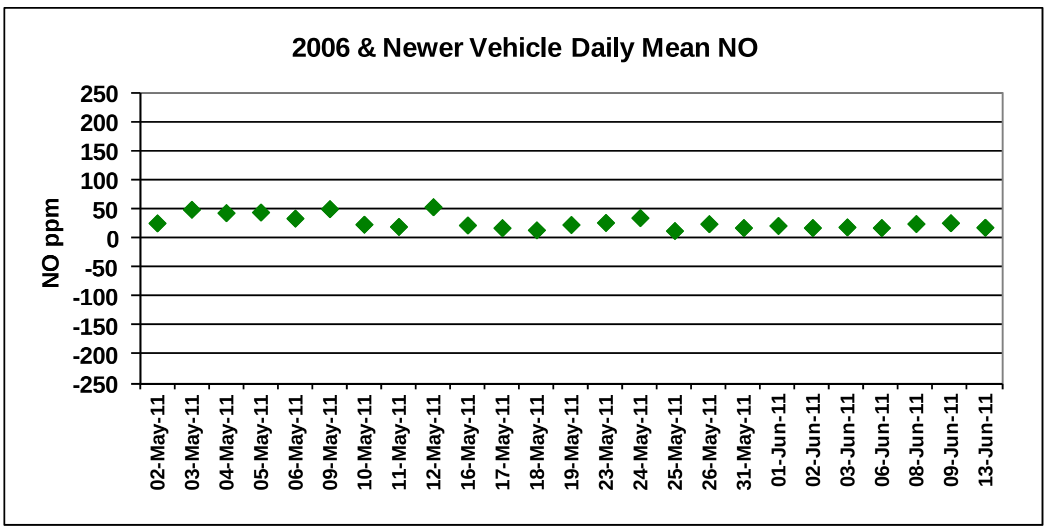


Figure III-3 Daily Mean NO for 2006 and Newer Vehicles



To further investigate individual vehicle measurement outliers, frequency distributions of HC, CO and NO were determined and plotted in Figures III-4 through III-6. There are small tails of negative values representing measurement noise and large tails of positive values representing high emitters.

Figure III-4 HC Frequency Distribution

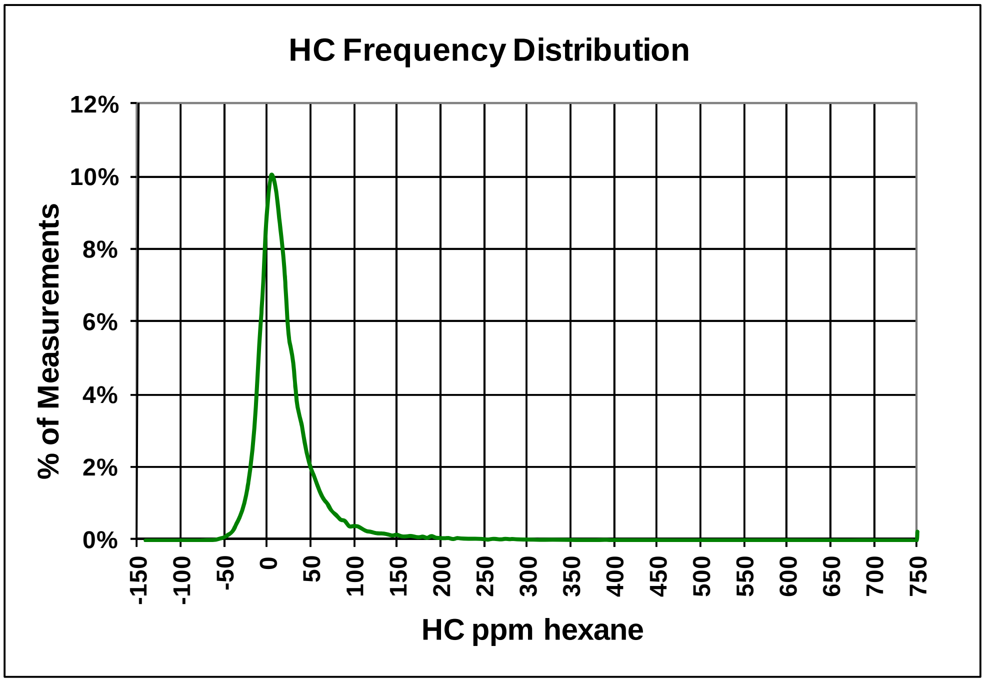


Figure III-5 CO Frequency Distribution

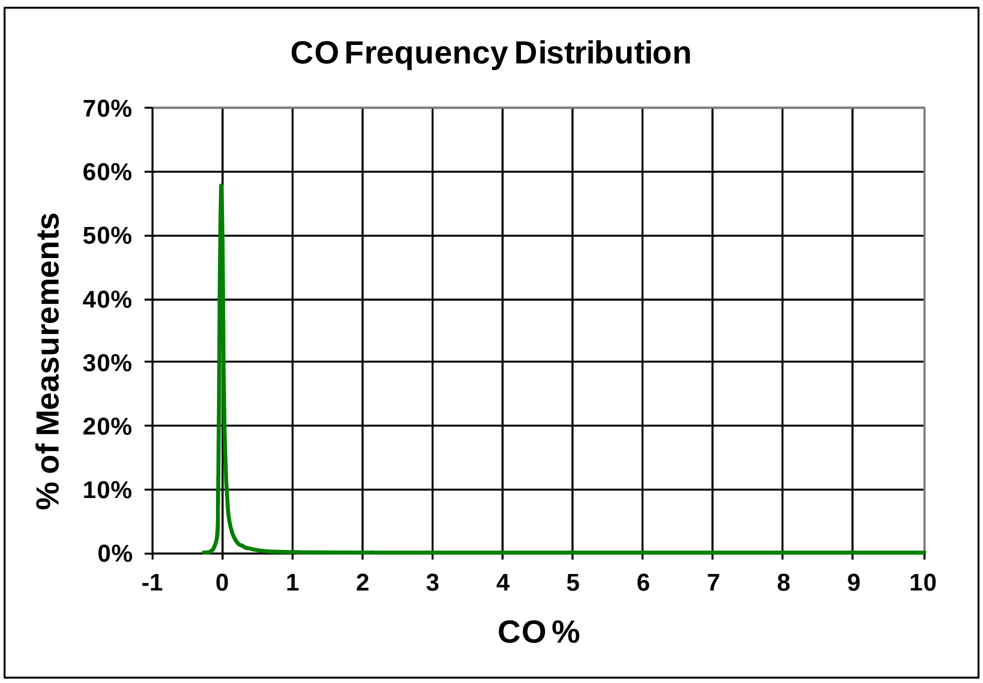
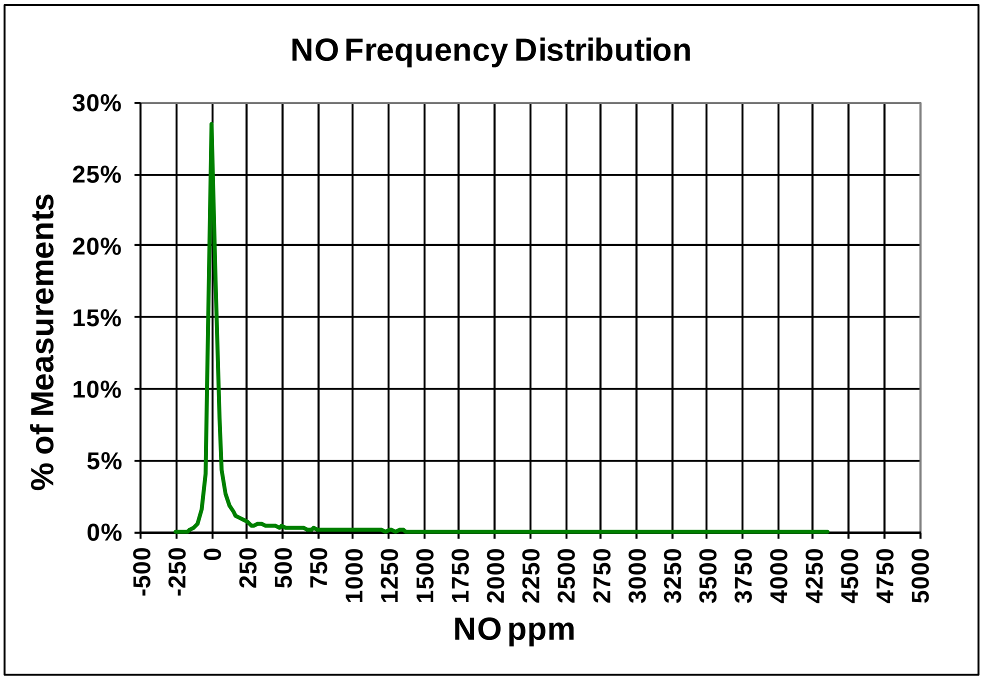


Figure III-6 NO Frequency Distribution

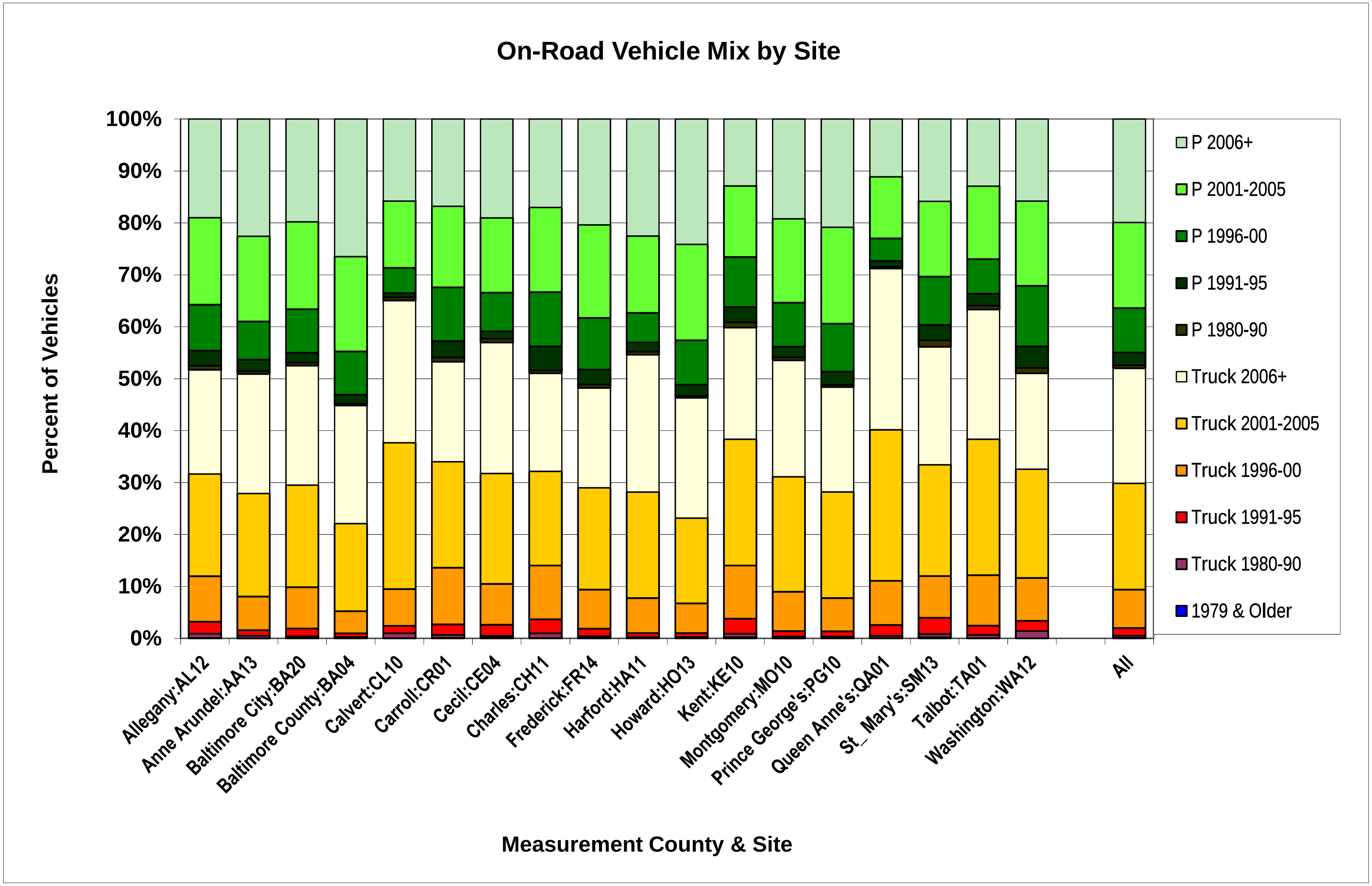


3. Vehicle Mix at Each Site

For vehicles matched to registration records, the vehicle type was decoded from the VIN into three groups: T- trucks less than 10,000 lbs GVWR, P – light passenger vehicle, and O – other, which includes heavier vehicles.

Figure III-7 Vehicle Mix by Site shows the percentage of each type/model year range measured at the sites in each county. The fleet is approximately evenly divided between light passenger vehicles, shown in shades of green and trucks less than 10,000 lbs GVWR shown in orange and red. However, there is significant variation between sites.

Figure III-7 Vehicle Mix by Site



4. Screening by VSP for Emissions Analysis

Range Vehicle Specific Power

Research[1] has shown that vehicle specific power (VSP) has an important effect on tailpipe emissions. VSP is the power needed to overcome forces acting on the vehicle. In order to compare RSD measurements taken at different sites and at different times, it is necessary to ensure the sets of measurements have similar distributions of vehicle engine load. RSD measurements have been screened to identify those collected when vehicles were operating within a moderate load range of from 3kilowatts per ton (kW/t) to 22 kilowatts per ton (kW/t). This is a range within the scope of the IM240 and Federal Test Procedure (FTP) tests and over which tailpipe emission concentrations are more stable. Results from vehicles measured outside this range are excluded from the charts and tables of emission values as their results are not comparable to I/M test results.

Vehicle Specific Power (VSP) is the vehicle engine power per unit mass required to overcome gravitational force, inertia, aerodynamic drag and rolling resistance[2]. Expressed in kilowatts per ton it is the sum of:

- Gravitational force: 4.39 x sin(Road grade degrees/57.3) x Speed mph
- Inertial force: 0.22 x Speed mph x Acceleration mph/s
- Aerodynamic drag: 0.0000272 x Speed^3 mph
- Rolling resistance: 0.0954 x Speed mph

The rate of fuel consumption is approximately proportional to VSP. At negative values of VSP, the inertia of the vehicle is greater than the opposing forces and power is either dissipated through the vehicle driving the engine or through braking and very little fuel is being used. This situation typically occurs on downhill grades or during deceleration. When a vehicle engine transitions from producing power to absorbing power, the tailpipe emissions concentrations can vary widely.

To avoid using measurements that are not representative of vehicle emissions performance within the power range contained in the federal certification test, measurements made below a vehicle specific power (VSP) of 3kW/t or above 22 kW/t have been screened. These measurements are excluded from the emissions analyses presented in following sections.

IV. On-Road Emissions

A. Emissions by Model Year

Figures IV-1 through IV-3 show emissions by model year for I/M area vehicles. Trucks are treated as a single class and 99.7% of trucks were less than 10,000 lbs GVWR. There were 51 trucks between 10-14,000 lbs GVWR and 16 trucks greater than 14,000 lbs.

Figure IV-4 shows the number of RSD measurements by model year. Total 2008 to 2010 models were 24% fewer than 2005 to 2007 models as a result of the recession with 2009 models 38% fewer than 2006. The percentage of trucks peaked in 2004 models at 58% of light vehicle models and has since declined. Projections of fleet age fractions for modeling future year emissions will need to account for these unusual changes in the light vehicle fleet mix.

The survey sample contained fewer than 100 measurements for 1991 and older passenger models and 1993 and older truck models. Consequently the average emissions values for older models are not precise.

The emissions follow the typical patterns for HC, CO and NOx[iv]. Newer vehicles have lower tailpipe concentrations than older vehicles. Model year 2000 and newer vehicles had lower HC and CO emission levels than older models. On average 1987-1995 model trucks had higher emissions than passenger vehicles.

NOx emissions for light vehicles were low for 2004-2011 models but increased almost linearly with model year age from 2003 models through 1992 models. On average trucks had higher NOx emissions than passenger vehicles.

[iv] The I/M humidity correction factor has been applied to NOx values reported in this and subsequent sections.

Figure IV-1 Average RSD CO Emissions by Model Year

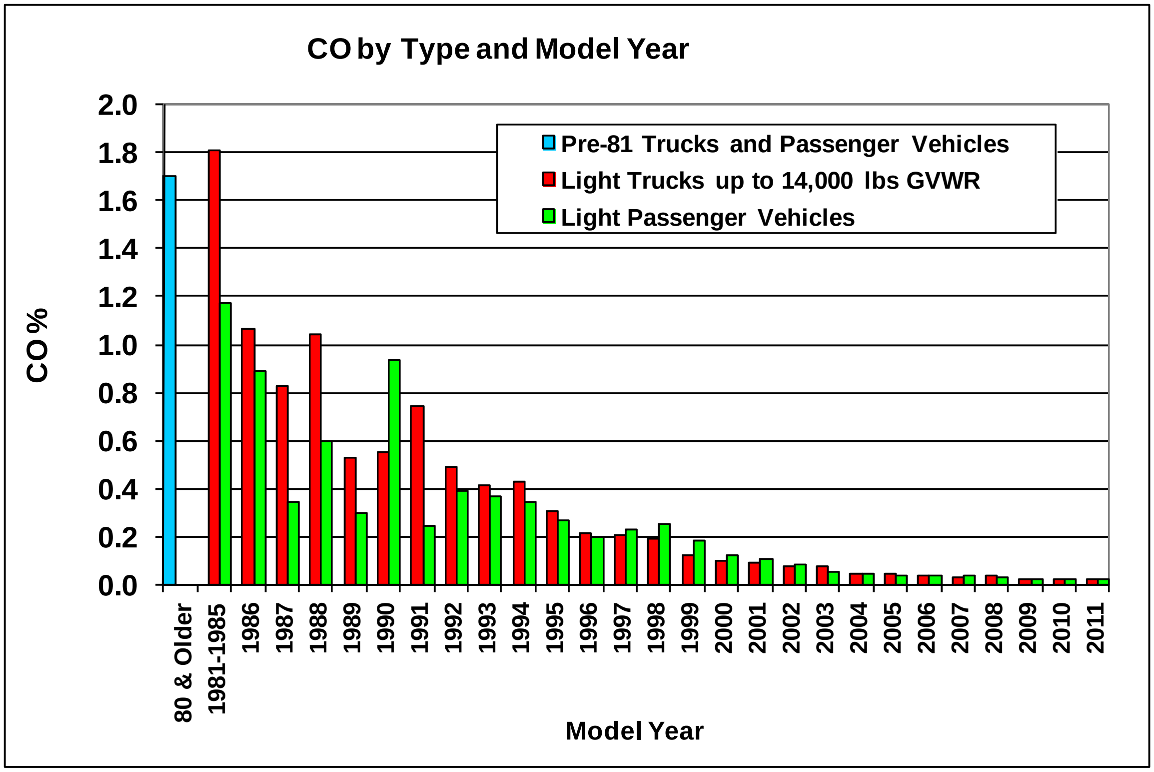


Figure IV-2 Average RSD HC Emissions by Model Year

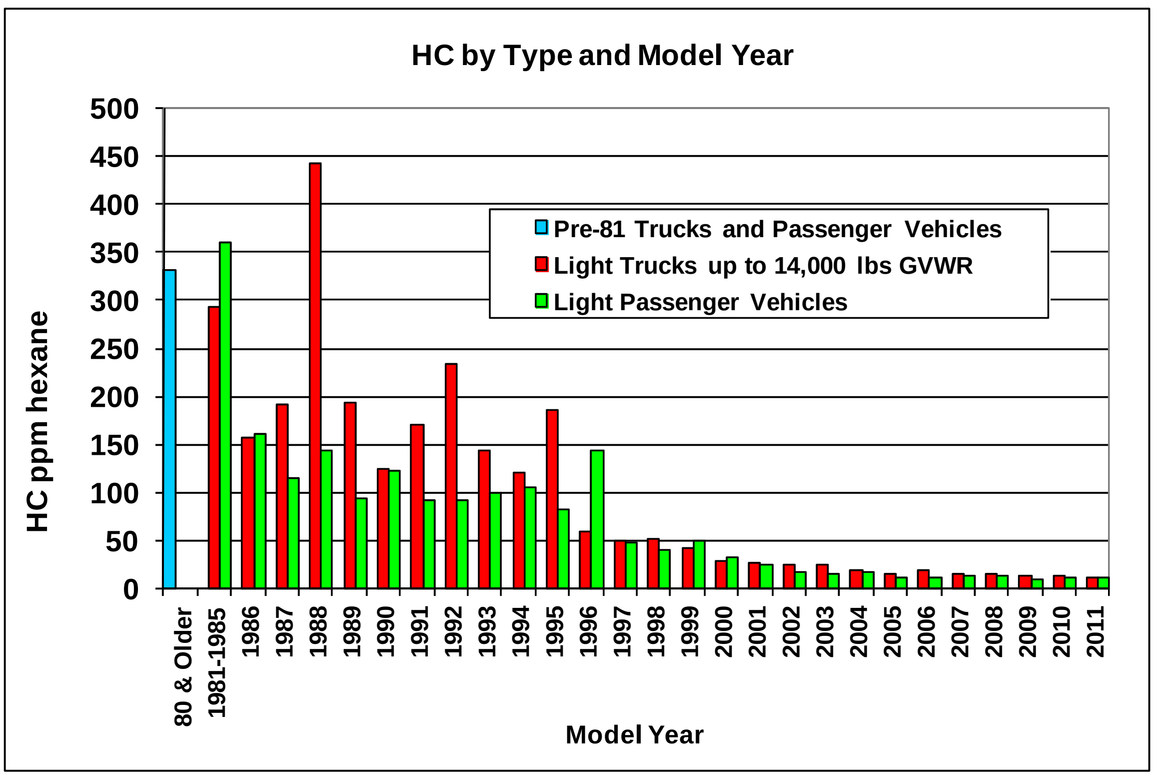


Figure IV-3 Average RSD NOx Emissions by Model Year

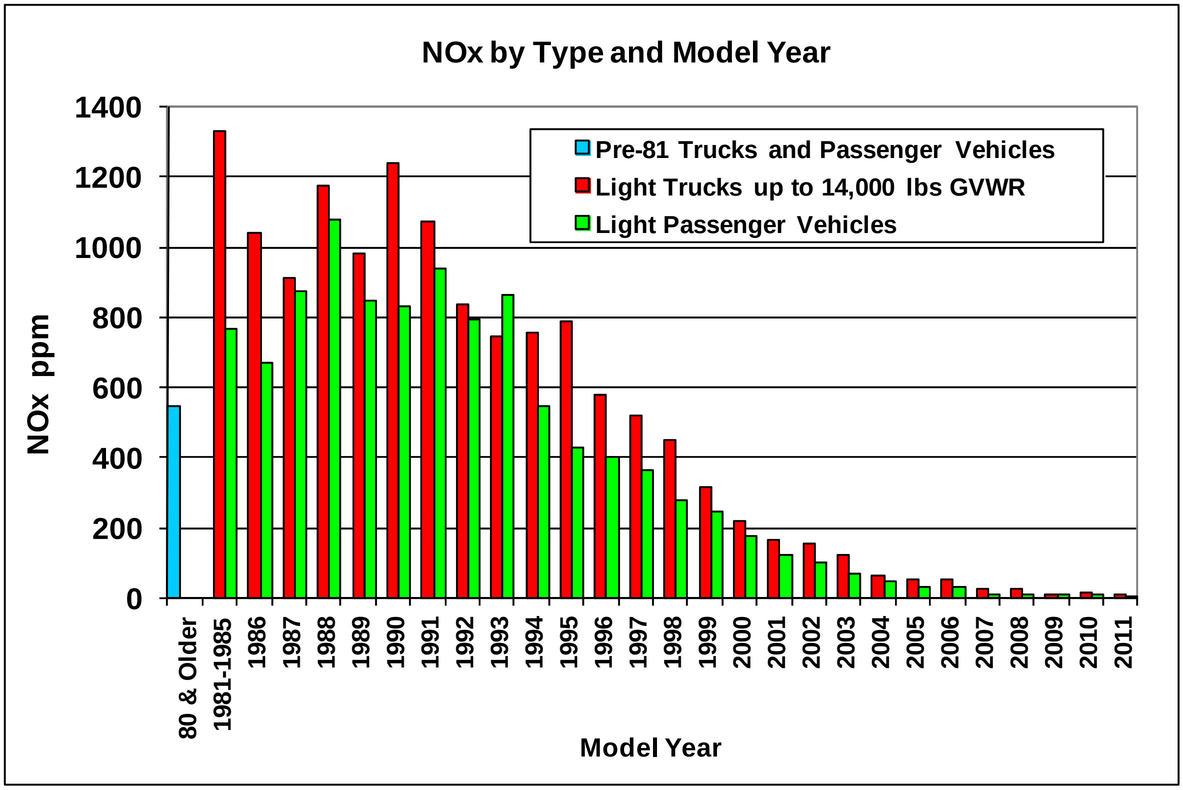
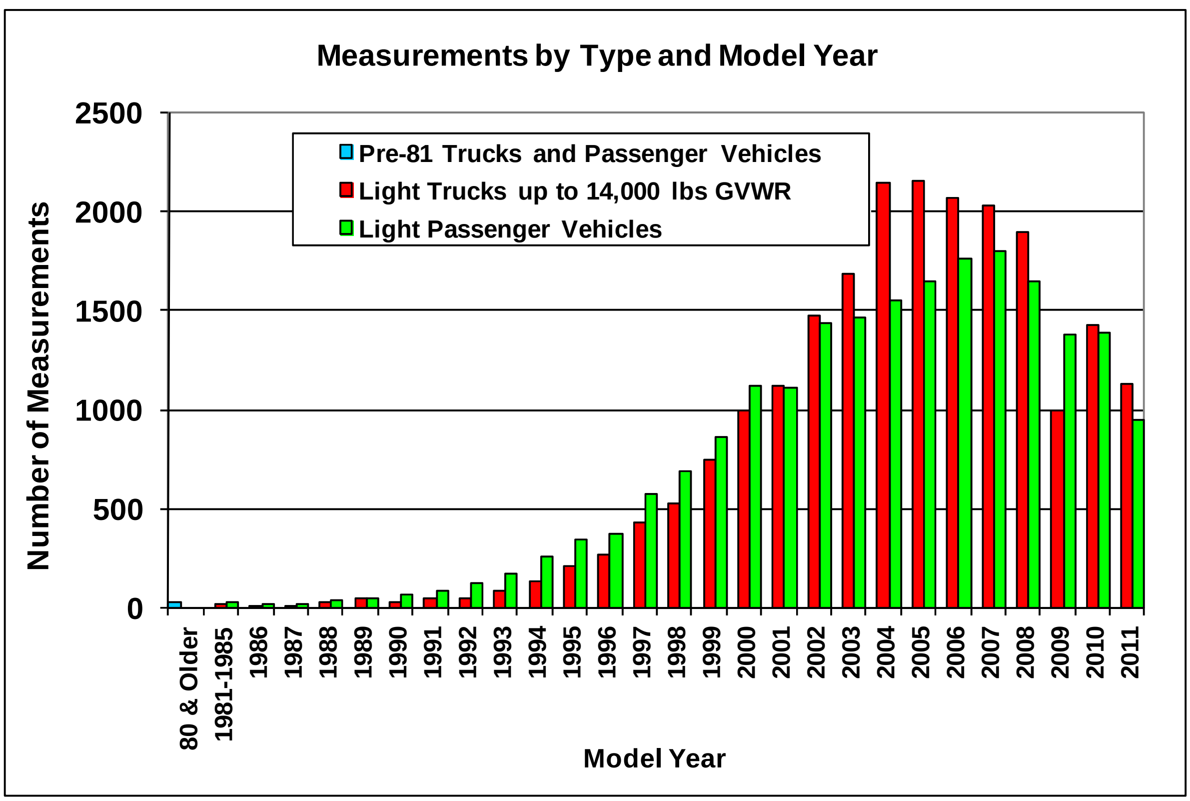


Figure IV-4 Measurements by Model Year



B. Emission Deciles by Model Year

The emission deciles for vehicles are shown in the following charts. These charts illustrate that high HC and CO emissions are more likely to occur among the oldest vehicles and are extremely high across a small portion of the fleet. NOx emissions are less extreme and more widely spread.

Figure IV-5 CO Deciles by Model Year

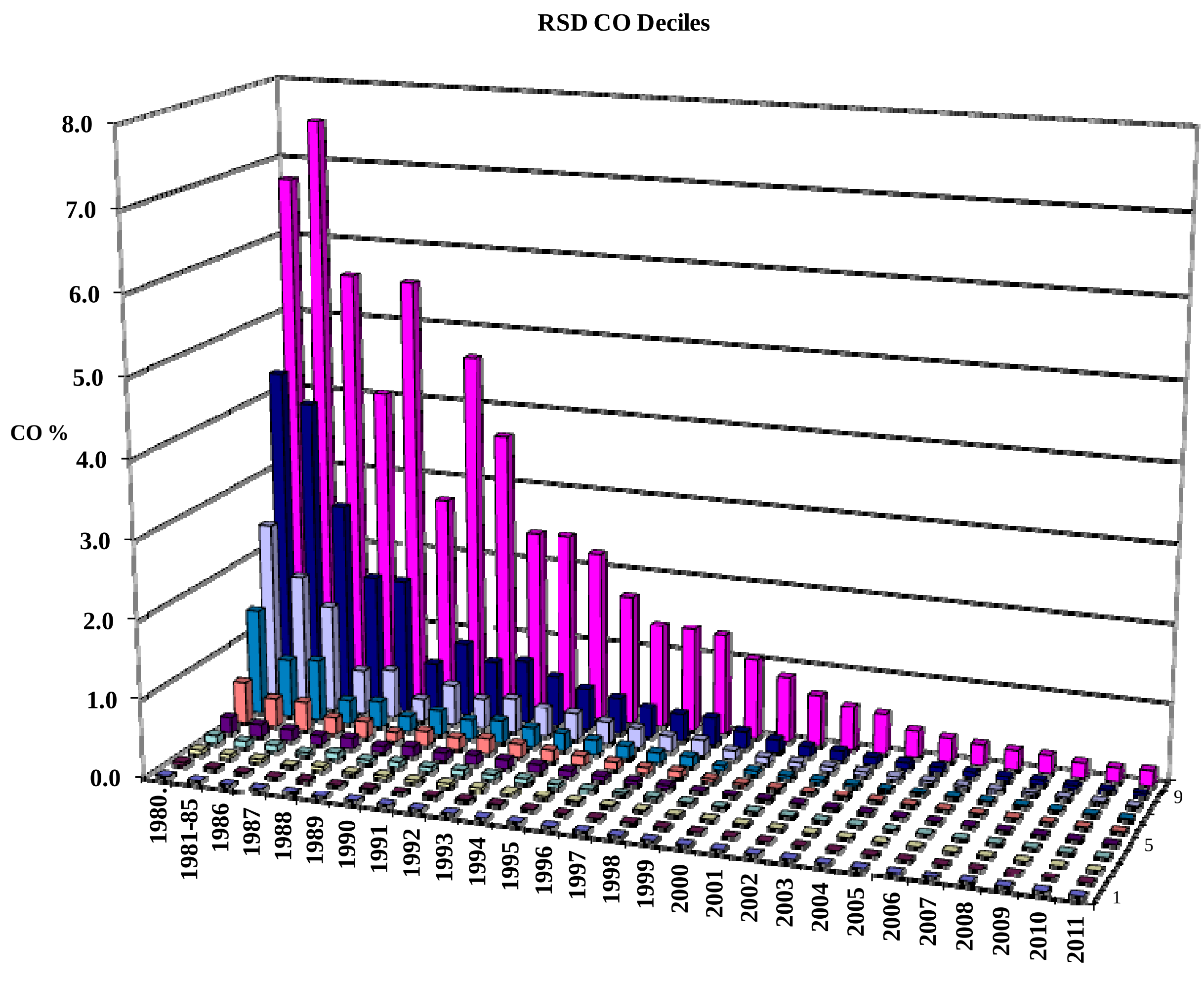


Figure IV-6 HC Deciles by Model Year

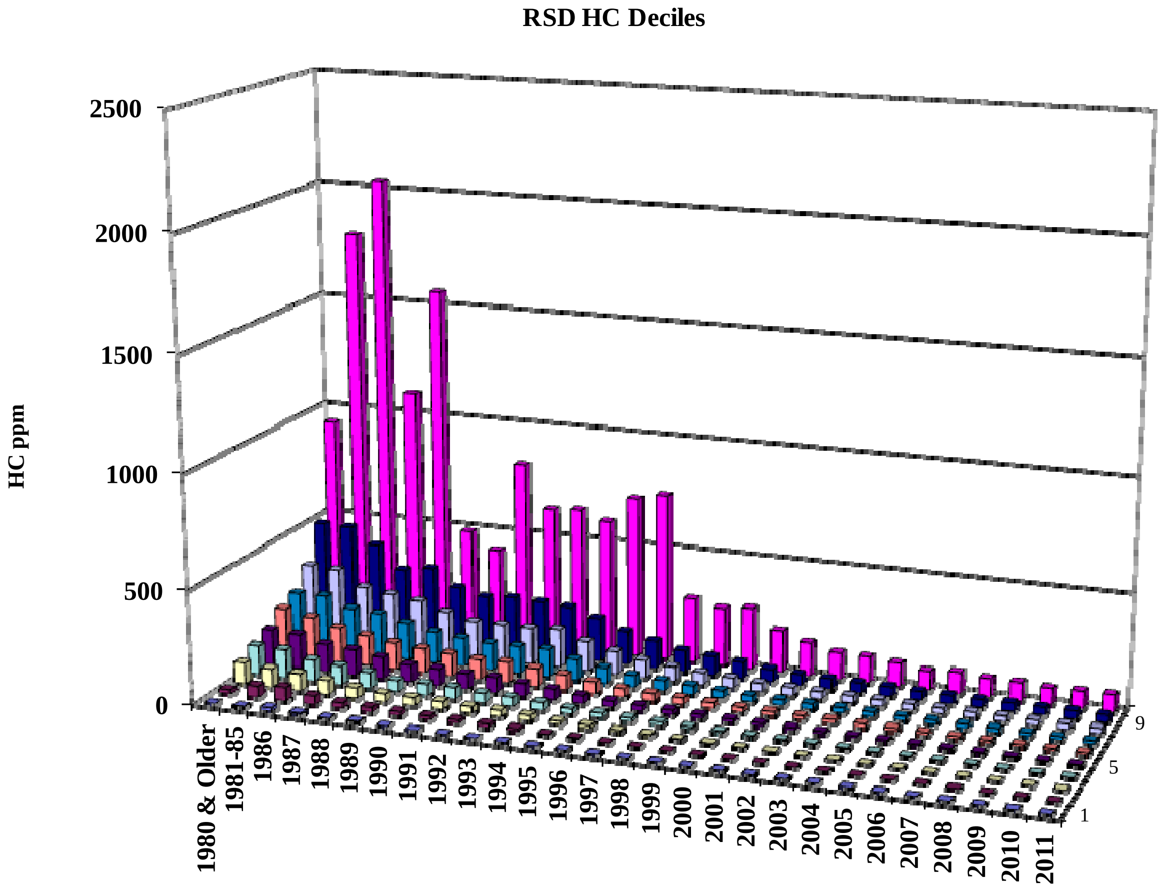
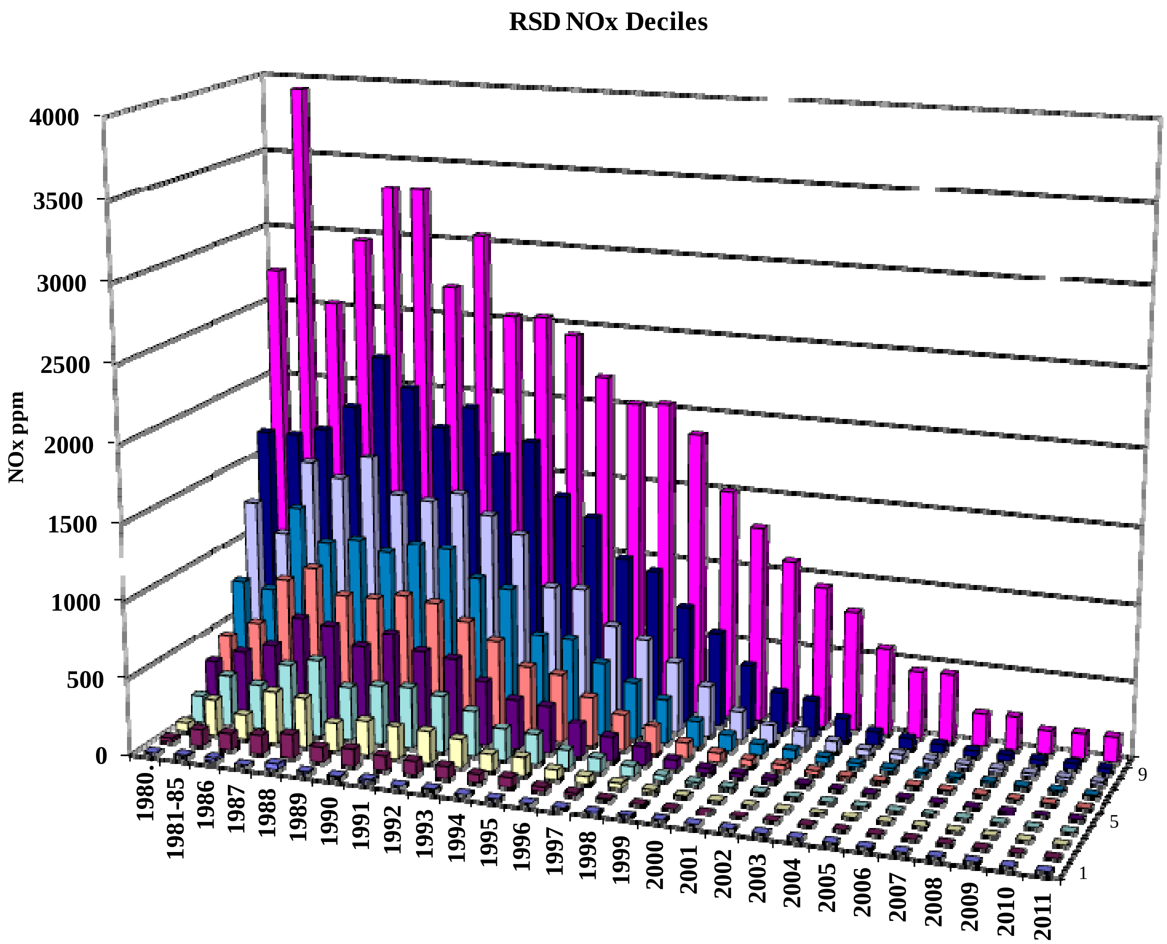


Figure IV-7 NOx Deciles by Model Year



V. Tested and Untested Vehicles

A. Percent of Vehicles Tested

The on-road vehicles with plates matching Maryland Motor Vehicle Administration registrations were compared against the database of I/M inspection results to determine the percentage of on-road vehicles that have been inspected. Tests from January 2009 through June 2011 were examined. This covers the period from two years four months before the start of the on-road survey in late early May through the end of the survey in mid June 2011.

Matching Vehicle Emissions Inspection Program (VEIP) inspection records were identified for 78% of the 1981 to 2008 model vehicles less than 10,000 lbs GVWR that were seen on the road and registered in counties subject to the VEIP program. The trends are shown by vehicle type and model year in Figure V-1. The first two model years are exempt from I/M inspection and 2009 models were part way through the inspection year when the matching tests were queried in June 2011.

Not all vehicles over 10,000 lbs GVWR are subject to the program – many are diesels – and diesels were not excluded from the vehicles seen on-road. Delayed recording of license plate transfers or address changes, remote sensing tag editing errors, VIN transcription errors, extensions, and late vehicles can all affect the number of vehicles matched to VEIP results.

For these reasons, the results presented in Figures V-1 and V-2 show the percentage of matched VEIP tests for 1981-2008 model vehicles less than 10,000 lbs to be 78% and for vehicles over 10,000 lbs there is a lower percentage of matched VEIP test data. However, just because vehicles were not found does not necessarily mean they were not tested.

The percentage of vehicles positively identified as being tested was lower in 2011 than in the 2009 survey. In the 2011 survey there is a noticeable biennial pattern with lower percentages of odd model vehicles being positively identified as being tested. It is possible this results from the I/M program transition that took place in 2009 during which the tests for many odd model year vehicles were delayed.

Figure V-2 shows there is a small variation in the percentage of on-road 1981 to 2008 model vehicles matched to VEIP tests by county of registration. VEIP tests were matched to 3% of vehicles registered in counties outside the I/M inspection program.

Figure V-1 % of Vehicles with I/M Tests

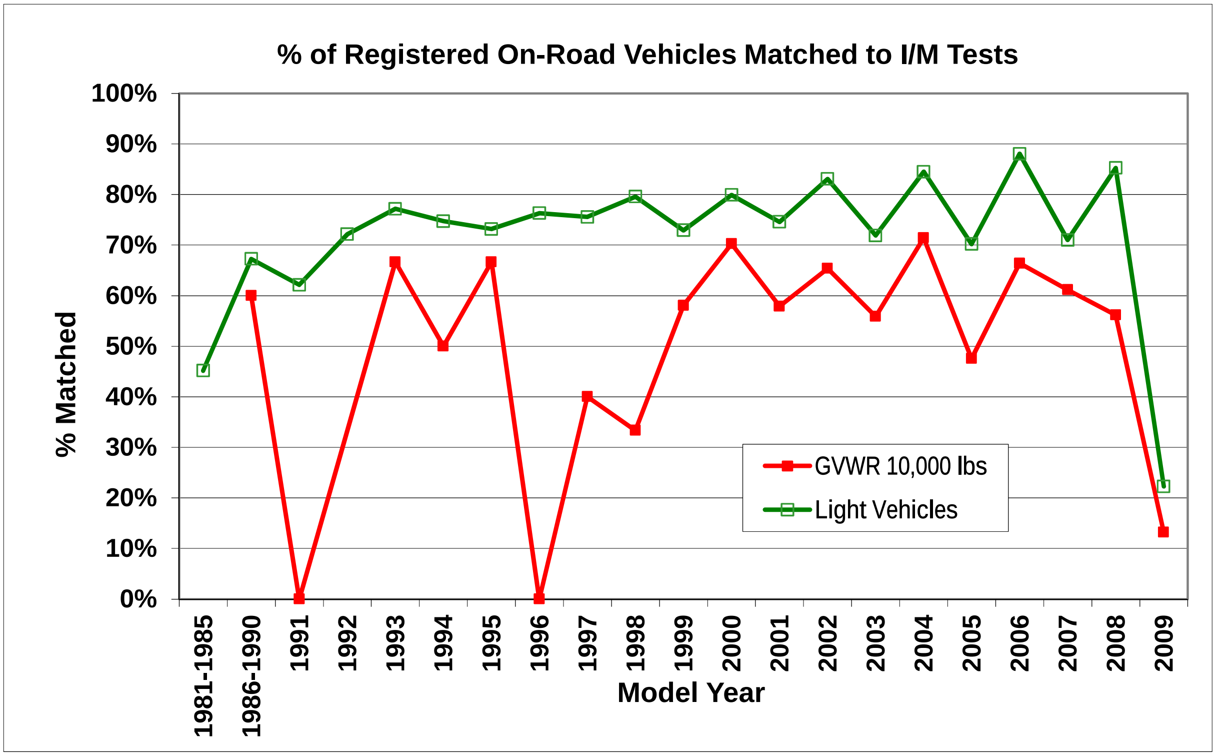
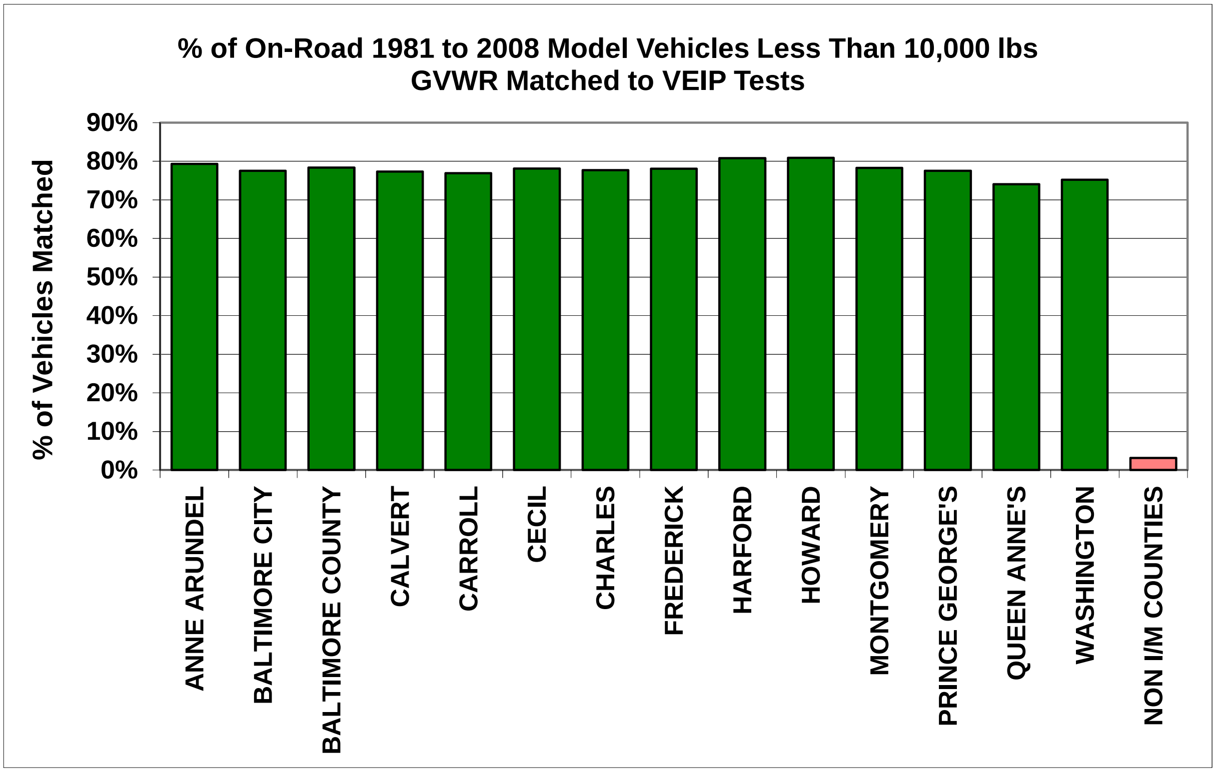


Figure V-2 On-Road Vehicles Matched to VEIP Tests by County of Registration



B. Vehicle Emissions by VEIP Status

The vehicles measured on-road and registered in VEIP counties were separated into three groups:

- Tested WF – vehicles registered to I/M counties for which the last matching VEIP test found was a waiver or a fail
- Unmatched – vehicles registered to I/M counties for which no matching VEIP inspection record was found
- Tested P – vehicles registered to I/M counties for which the last matching I/M test found was a pass

As noted earlier, only part of model year 2009 vehicles had been I/M inspected and model years 2010 and 2011 were exempt at the time of the remote sensing survey. Therefore, only model years 2008 and older were included in this comparison.

Figures V-3 through V-8 compare the emissions for these three groups of vehicles. This comparison should be treated with some caution as site-to-site differences have an effect on the emissions levels observed. In addition, the 'Tested WF' bins for '1990 & older' and '1991-1995' vehicles contained fewer than 25 measurements.

The 1995 and older model vehicles whose last test resulted in a waiver or a fail typically had much higher emissions of HC and CO. The 1990 and older model vehicles that were not matched to a recent test result also had higher average HC and CO and this was also the case for 1991-1995 light trucks.

The 1996-2008 model vehicles whose last test resulted in a waiver or a fail had higher emissions of all pollutants.

Figure V-3 Passenger Vehicle CO by VEIP Status

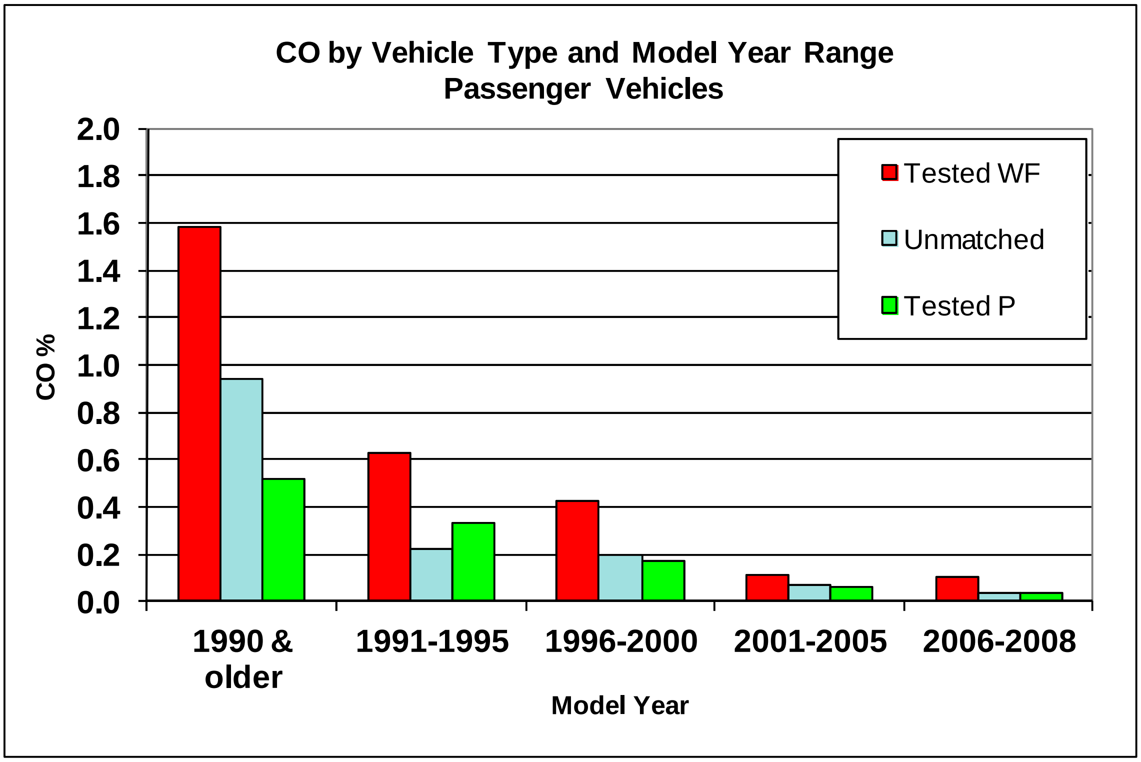


Figure V-4 Light Truck CO by VEIP Status

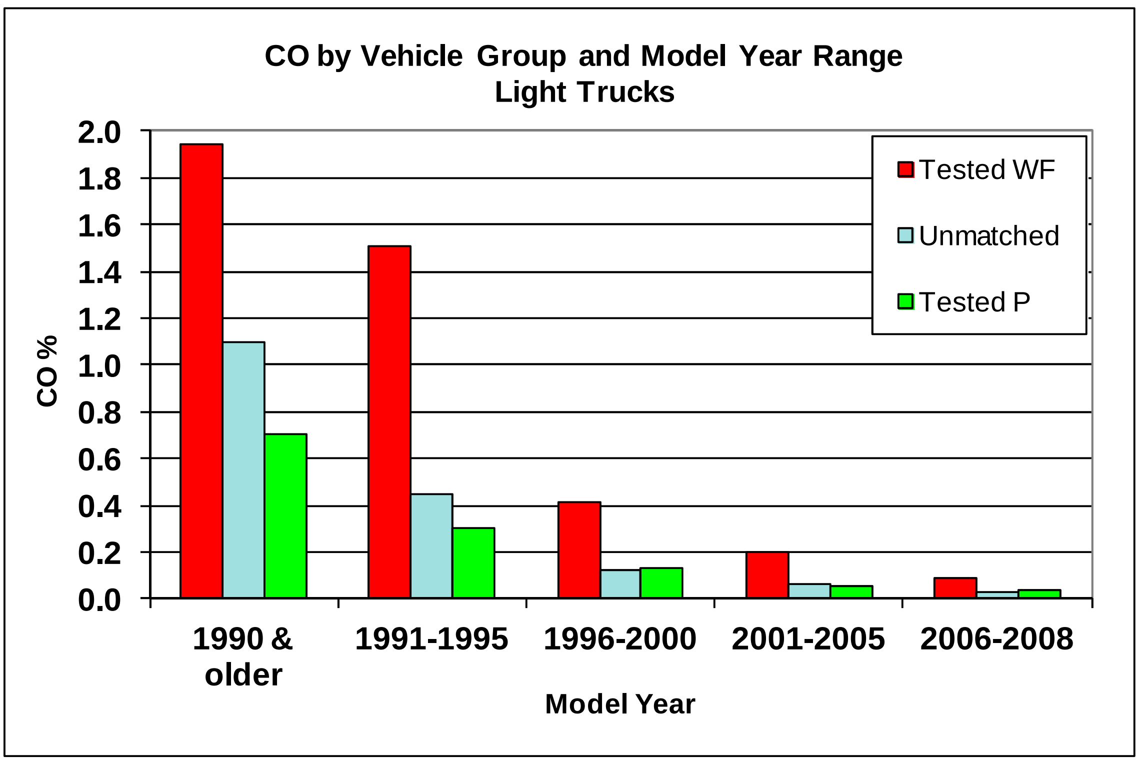


Figure V-5 Passenger Vehicle HC by VEIP Status

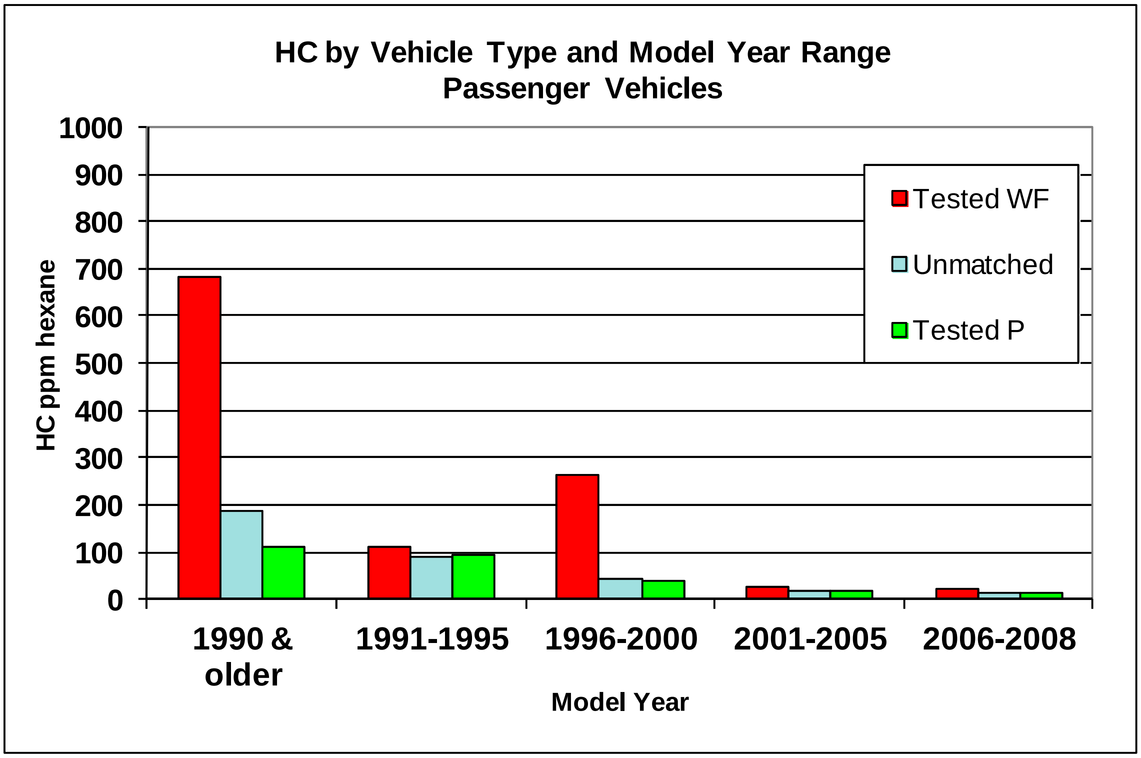


Figure V-6 Light Truck HC by VEIP Status

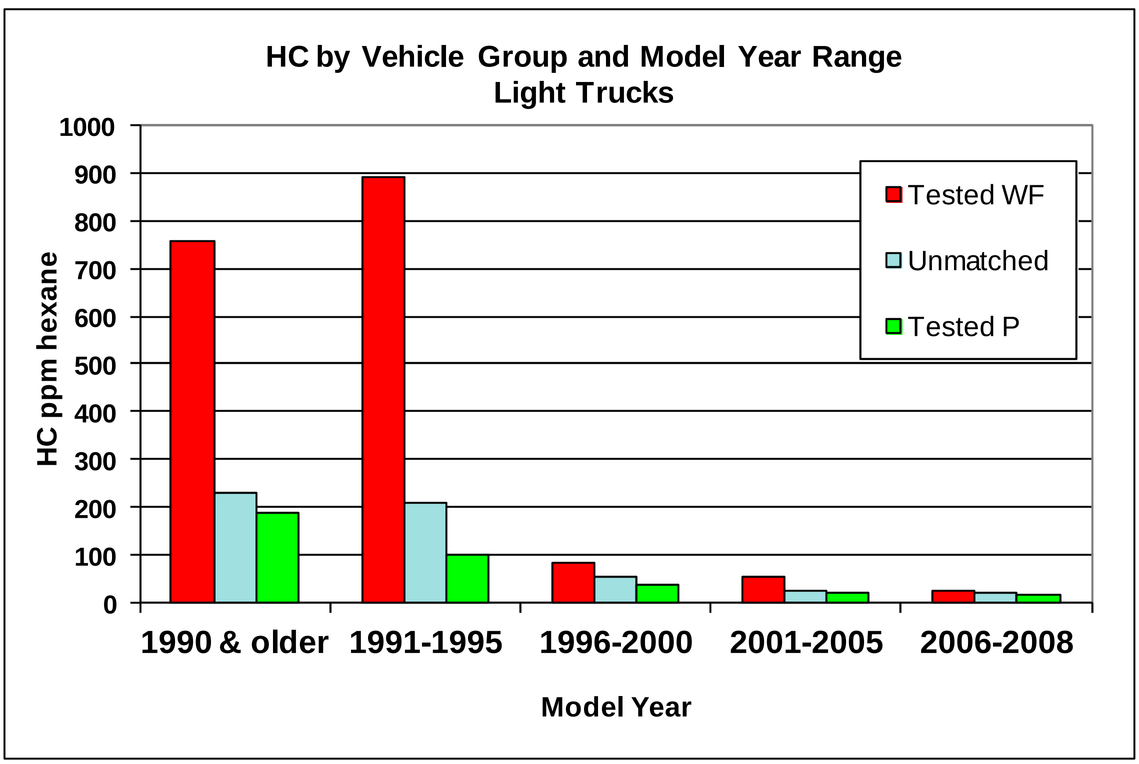


Figure V-7 Passenger Vehicle NOx by VEIP Status

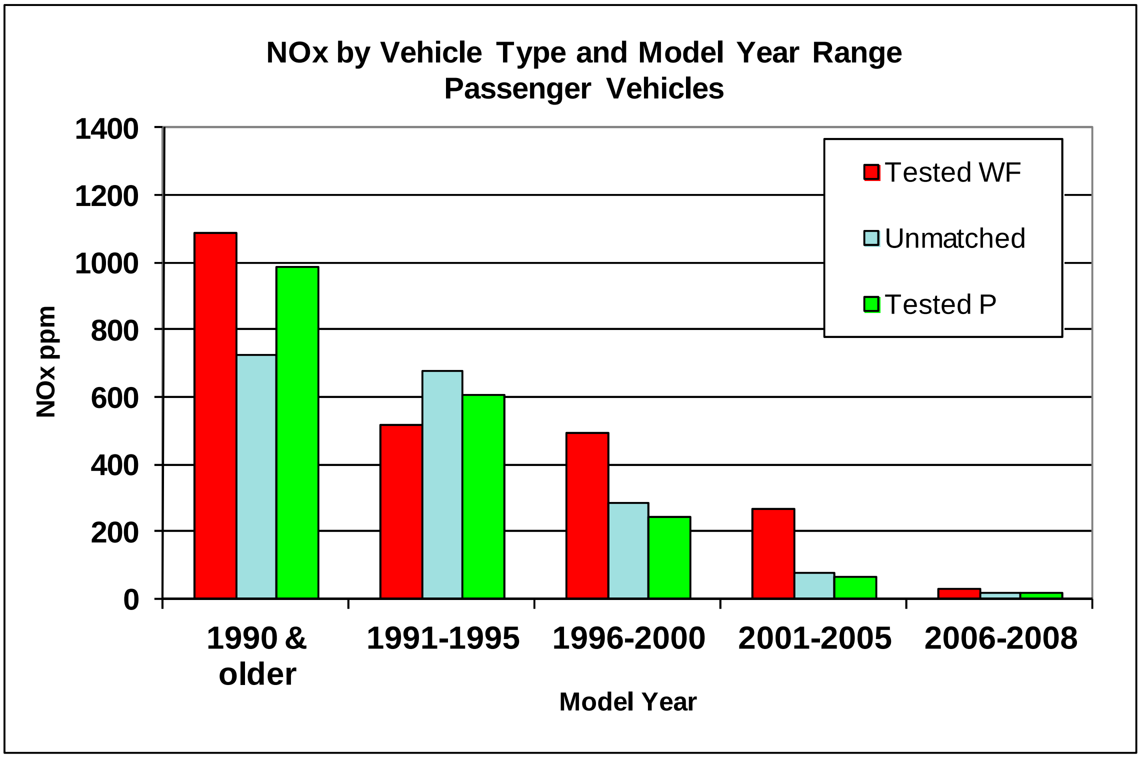
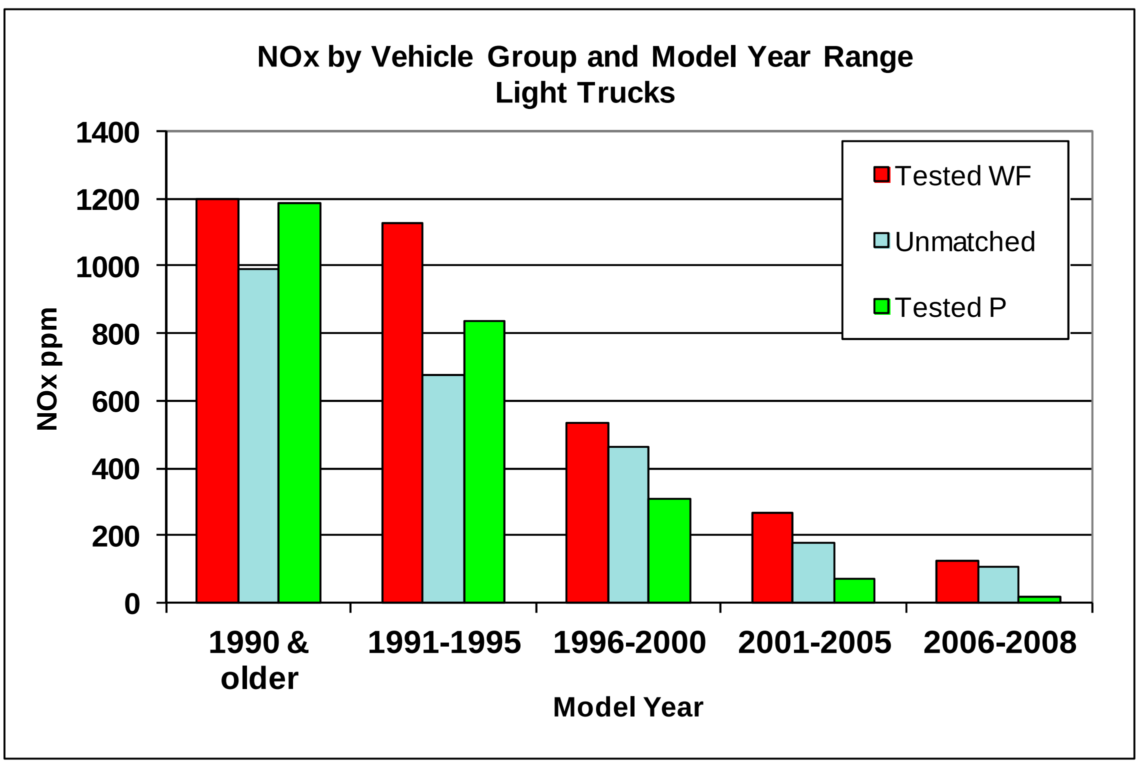


Figure V-8 Light Truck NOx by VEIP Status



C. I/M and Non I/M Emissions

The vehicles measured on-road were separated into two groups based on their registration county:

- Non-VEIP– vehicles registered to counties outside the VEIP testing area;
- VEIP counties & Baltimore City

The results are plotted in Figures V-9 through V-11. The combined sample of passenger vehicles and light trucks registered in non-I/M counties contains 8,675 measurements. For both passenger vehicles and trucks, the average emissions of I/M registered vehicles are lower than those of non-I/M registered vehicles for HC, CO and NOx.

Figure V-9 I/M and Non-I/M -CO

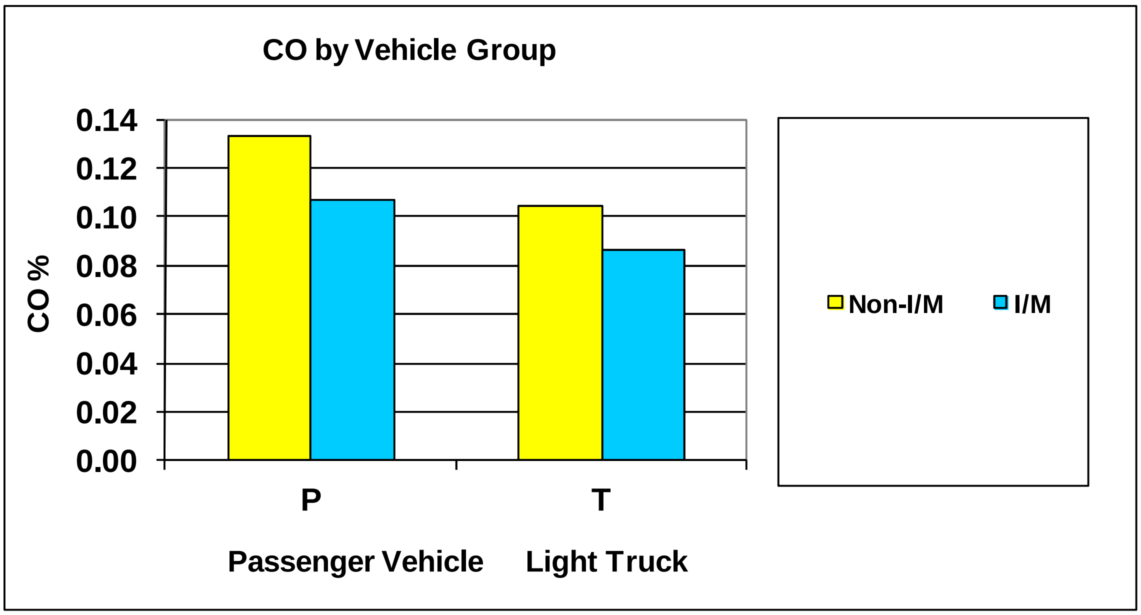


Figure V-10 I/M and Non-I/M - HC

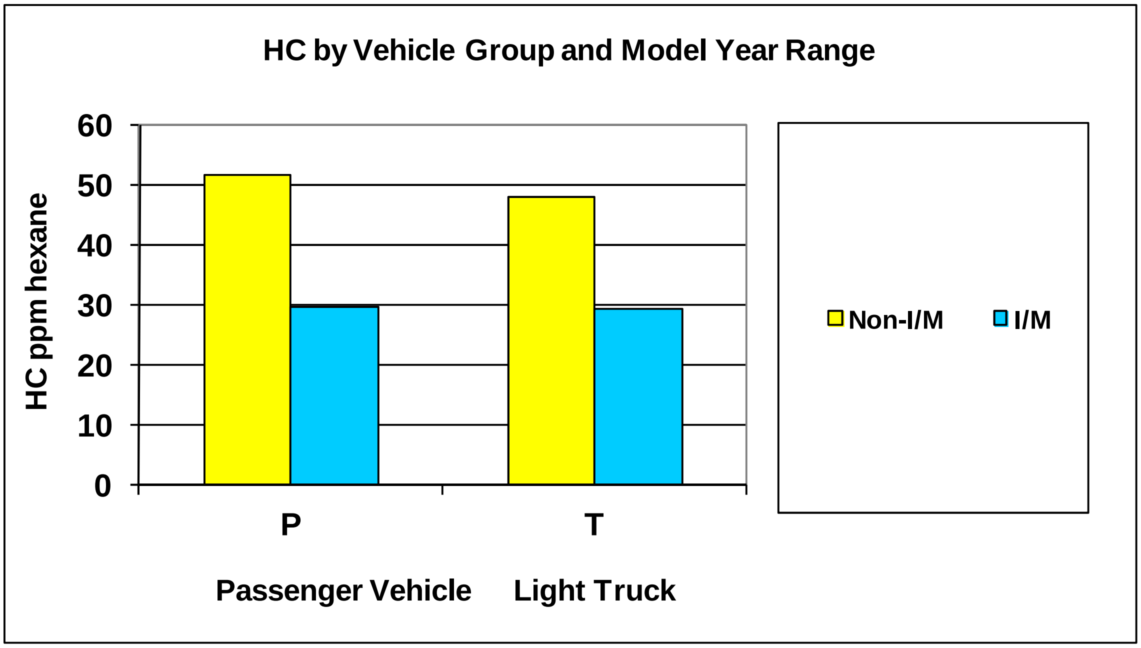
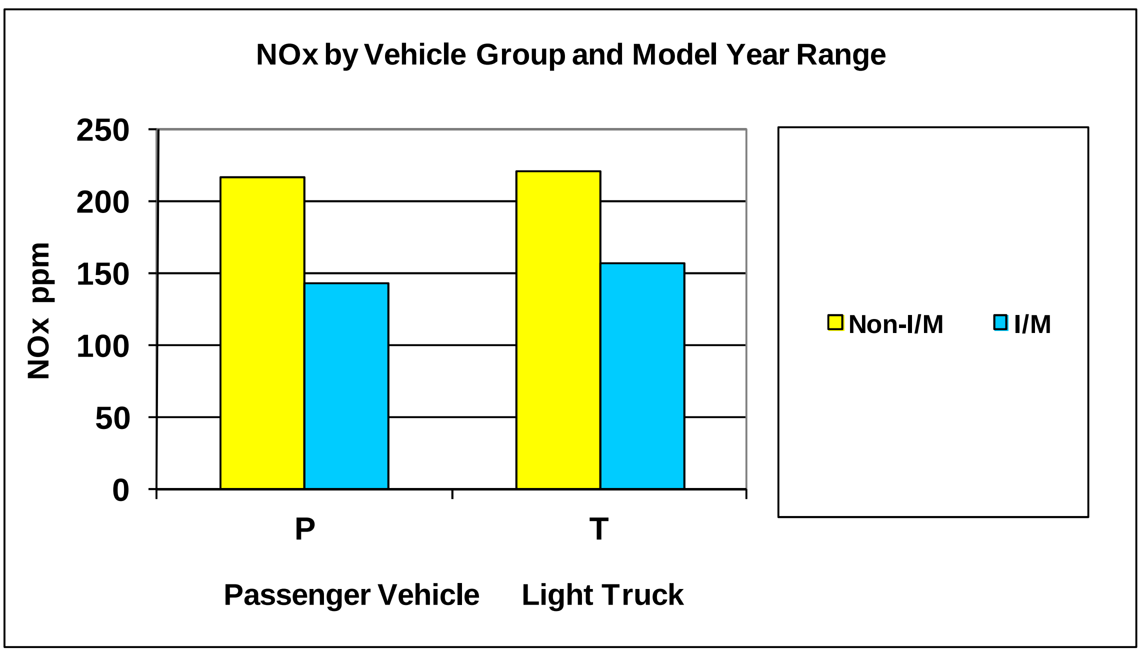


Figure V-11 I/M and Non-I/M - NOx



D. Non-VEIP Traffic in VEIP Counties

Table V-I lists the number and percentage of non-VEIP County vehicles observed at VEIP County sites. Approximately 1.2% of light vehicle traffic in VEIP counties was registered in non-VEIP counties.

Table V-1 Non-I/M County Registered Vehicles at I/M County Sites

County	Site	City	Non-VEIP Vehicles	Non-VEIP % of Traffic
Anne Arundel	AA13	Annapolis	60	1.6%
Baltimore City	BA20	Baltimore	16	0.7%
Baltimore County	BA04	Cockeysville	24	0.3%
Calvert	CL10	Dunkirk	4	0.6%
Carroll	CR01	Westminster	7	0.3%
Cecil	CE04	Port Deposit	4	0.3%
Charles	CH11	Waldorf	75	4.8%
Frederick	FR14	Frederick	13	0.5%
Harford	HA11	Belair	9	0.4%
Howard	HO13	Jessup	17	0.5%
Montgomery	MO10	Burtonville	27	0.4%
Prince George's	PG10	Bowie	85	1.4%
Queen Anne's	QA01	Centreville	143	23.0%
Washington	WA12	Hagerstown	8	0.4%
Total I/M Counties			492	1.2%

VI. High Emitters

For this survey, high emitters were identified using cutpoints listed in Table VI-1. Vehicles have been divided into three classes: 1) 0 to 6,000 lbs, 2) 6,001 to 10,000 lbs, and 3) over 10,000 lbs. The cutpoints for HC in this table are specified in ppm hexane, i.e. concentrations of C_6 molecules, which is consistent with most I/M inspection equipment used to measure tailpipe concentrations. Remote sensing NOx emissions were corrected for humidity as described in Section III before being compared to the high emitter standards.

Table VI-1 On-Road High Emitter Cutpoints

	GVWR <= 6,000 lbs			GVWR 6,001-10,000 lbs			GVWR 10,001+ lbs		
Year	HC (ppm)	CO (%)	NOx (ppm)	HC (ppm)	CO (%)	NOx (ppm)	HC (ppm)	CO (%)	NOx (ppm)
1977	700	7	2,718	700	7	2,557	700	7	5,000
1978	645	7	2,718	700	7	2,557	700	7	5,000
1979	600	6	2,718	700	7	2,045	700	7	5,000
1980	330	2.6	2,718	525	7	2,045	700	7	5,000
1981	330	1.8	2,718	375	4.5	2,045	700	7	5,000
1982	330	1.8	2,718	330	3.8	2,045	700	7	5,000
1983	330	1.8	2,718	330	2.3	2,045	700	5.3	5,000
1984	264	1.8	2,252	311	1.8	1,969	660	4.5	4,500
1985	264	1.8	2,252	292	1.8	1,969	660	4.5	4,500
1986	264	1.8	2,252	292	1.8	1,969	420	3.8	4,500
1987	264	1.8	2,252	187	1.8	1,969	330	1.8	4,500
1988	264	1.8	1,243	180	1.8	1,917	330	1.8	4,500
1989	264	1.8	1,243	180	1.8	1,917	330	1.8	4,500
1990	264	1.8	1,243	180	1.8	1,917	330	1.8	4,500
1991	208	1.8	1,087	168	1.8	1,457	330	1.8	4,000
1992	208	1.8	1,087	168	1.8	1,457	330	1.8	4,000
1993	208	1.8	1,087	168	1.8	1,457	330	1.8	4,000
1994	208	1.8	1,087	168	1.8	1,457	330	1.8	4,000
1995	208	1.8	1,087	168	1.8	1,457	330	1.8	4,000
1996+	100	1.0	893	168	1.0	1,457	330	1.8	3,600

In order to be considered a high emitter in Maryland, a vehicle must have 2 or more readings that exceed the standards for the same pollutant on different days. If the standard is exceeded by less than the tolerance of the RSD unit, a third measurement is required for confirmation. Vehicles with out-of-State registrations were not considered in the high emitter analysis because their type and model year was unknown. Correct high emitter cutpoints cannot be selected without this information.

Some 2,412 vehicles had two or more valid remote sensing measurements on different days within the normal VSP operating range of 3 to 22 kW/t. Fifty two (52) of these exceeded the cutpoints on both of their last two measurements for the same pollutant.

Twenty-eight (28) vehicles exceeded the standard by more than the tolerance of the RSD unit on their last two measurements and qualify as high emitters. Twenty-four (24) suspected high emitting vehicles required additional confirmation by a third measurement. Two of these vehicles had a third measurement. In one case the vehicle was confirmed as a high emitter of HC. In the second case the high emitter status was not confirmed although the third measurement reported emissions were higher than average.

The high emitters and suspected high emitters by pollutant are summarized in Table VI-2.

Table VI-2 High Emitters by Pollutant

Pollutant Exceeded	High Emitter	Suspected	Total
HC only	3	12	15
CO only	1	1	2
NO only	12	9	21
HC & CO	2	0	2
HC & NOx	10	2	12
CO & NOx	0	0	0
All	0	0	0
Total	28	24	52

The high emitters that exceeded the standard by more than the tolerance of the RSD unit on their last two measurements are listed in Table VI- 3. Those requiring a third measurement are listed in Table VI-4.

Table VI-5 shows the emissions for the two vehicles requiring confirmation by a third measurement. The third row shows the emissions for the one high emitter that also had third measurement. It confirmed the high emitter finding.

Table VI-3 High Emitters

			Registration	Date		HC Values			CO Values			NOx Values		
Year	Make	Body Style	County	Last	Prev	Std	Last	Prev	Std	Last	Prev	Std	Last	Prev
High Emitters (Last two measurements both exceed the emissions standards for at least one pollutant by more than the RSD tolerance).														
1991	DODG	VN	PG	13-Jun-11	02-Jun-11	208	(4)	105	1.8	0.1	0.1	1,087	1,588	1,709
1992	BUIC	SW	PG	13-Jun-11	02-Jun-11	208	44	48	1.8	0.0	0.1	1,087	3,692	1,462
1993	DODG	VN	K	06-May-11	03-May-11	208	301	221	1.8	0.2	0.2	1,087	2,674	1,790
1993	NISS	2H	M	05-May-11	04-May-11	208	87	111	1.8	0.1	0.1	1,087	2,441	2,599
1993	FORD	TK	M	08-Jun-11	01-Jun-11	168	468	373	1.8	0.5	1.4	1,457	927	1,637
1994	VOLV	4S	K	03-May-11	02-May-11	208	494	359	1.8	0.1	0.1	1,087	552	167
1995	ACUR	4S	BA	03-Jun-11	25-May-11	208	226	241	1.8	0.7	0.6	1,087	1,836	2,300
1995	HOND	4S	PG	08-Jun-11	01-Jun-11	208	18	65	1.8	0.2	0.3	1,087	1,434	1,709
1995	MERZ	4S	BA	03-Jun-11	25-May-11	208	1,189	1,798	1.8	1.2	0.8	1,087	1,417	1,188
1995	PONT	4S	STM	03-Jun-11	25-May-11	208	218	279	1.8	0.6	0.3	1,087	1,607	1,763
1995	CHEV	SU	PG	13-Jun-11	02-Jun-11	208	123	226	1.8	0.3	0.6	1,087	2,079	1,541
1996	FORD	4S	K	03-May-11	02-May-11	100	2,924	307	1.0	0.2	0.0	893	554	311
1997	FORD	VN	M	08-Jun-11	01-Jun-11	168	44	139	1.0	0.1	0.4	1,457	2,298	1,714
1998	TOYT	4S	BC	03-Jun-11	25-May-11	100	165	112	1.0	0.6	0.3	893	2,332	1,715
1999	DODG	VN	QA	03-May-11	02-May-11	100	103	126	1.0	0.3	0.2	893	1,843	2,116
1999	DODG	4S	BA	03-Jun-11	25-May-11	100	2,682	2,340	1.0	0.5	0.4	893	2,438	1,997
1999	HOND	4S	BA	03-Jun-11	25-May-11	100	26	17	1.0	0.0	0.0	893	2,944	3,573
2000	HOND	4S	BA	03-Jun-11	25-May-11	100	112	117	1.0	0.5	0.3	893	1,881	1,692
2001	HOND	TK	M	08-Jun-11	01-Jun-11	100	255	179	1.0	3.0	2.0	893	1,438	885
2001	VOLK	4S	K	03-May-11	02-May-11	100	137	199	1.0	0.8	0.8	893	1,509	1,870
2001	VOLK	4S	K	06-May-11	05-May-11	100	63	25	1.0	0.1	0.0	893	2,528	2,744
2001	CHEV	VN	AA	01-Jun-11	26-May-11	100	137	156	1.0	0.4	0.5	893	1,501	2,455
2001	CHEV	TK	STM	02-Jun-11	10-May-11	168	193	25	1.0	0.0	0.0	1,457	3,068	1,828
2001	DODG	TK	CA	03-May-11	02-May-11	168	55	42	1.0	0.0	0.0	1,457	3,498	2,970
2002	SATU	4S	BA	03-Jun-11	25-May-11	100	32	30	1.0	0.0	0.0	893	2,552	2,395
2002	SUBA	4S	BC	09-Jun-11	26-May-11	100	61	74	1.0	2.1	2.2	893	(27)	5
2003	FORD	DS	T	05-May-11	04-May-11	168	109	43	1.0	0.0	0.0	1,457	2,100	2,834
2005	MAZD	TK	CA	06-May-11	03-May-11	100	462	269	1.0	1.8	2.2	893	643	532

Table VI-4 Suspected High Emitters Requiring a Third Measurement

			Registration	Date		HC Values			CO Values			NOx Values		
Year	**Make**	**Body Style**	**County**	**Last**	**Prev**	**Std**	**Last**	**Prev**	**Std**	**Last**	**Prev**	**Std**	**Last**	**Prev**
A third reading is needed to verify high emitter status (The last two measurements exceed standard by less than the RSD tolerance).														
1987	CHEV	TK	CA	05-May-11	04-May-11	187	138	240	1.8	0.8	0.5	1,969	1,993	2,861
1991	TOYT	VN	PG	08-Jun-11	01-Jun-11	208	65	78	1.8	0.4	0.0	1,087	1,432	1,299
1993	CHEV	VN	K	06-May-11	03-May-11	208	273	278	1.8	0.3	0.1	1,087	1,178	334
1994	HOND	4D	BC	09-Jun-11	26-May-11	208	33	68	1.8	0.2	0.4	1,087	1,202	1,271
1994	DODG	TK	K	06-May-11	03-May-11	168	201	235	1.8	0.5	0.5	1,457	1,278	2,689
1995	MAZD	4S	BC	05-May-11	04-May-11	208	339	151	1.8	2.8	1.2	1,087	1,323	1,150
1995	PLYM	VN	BA	09-Jun-11	26-May-11	208	3	21	1.8	0.0	0.1	1,087	1,403	1,129
1996	HOND	2S	M	08-Jun-11	01-Jun-11	100	98	72	1.0	0.5	0.2	893	918	1,146
1996	TOYT	4S	M	08-Jun-11	01-Jun-11	100	161	186	1.0	0.3	0.9	893	383	268
1996	DODG	VN	STM	11-May-11	10-May-11	100	156	223	1.0	0.2	0.2	893	744	469
1996	TOYT	TK	PG	08-Jun-11	01-Jun-11	168	219	281	1.0	0.4	0.5	1,457	298	652
1997	CHEV	2H	M	08-Jun-11	01-Jun-11	100	124	157	1.0	0.6	0.8	893	1,330	1,009
1997	CHRY	4S	K	06-May-11	03-May-11	100	168	942	1.0	0.0	0.1	893	148	55
1997	TOYT	4S	BA	03-Jun-11	25-May-11	100	344	110	1.0	1.0	0.1	893	726	1,311
1997	TOYT	4S	QA	05-May-11	04-May-11	100	223	282	1.0	0.3	0.3	893	1,522	859
1997	CADI	4S	CH	13-Jun-11	02-Jun-11	100	140	314	1.0	0.0	0.4	893	36	120
1999	HOND	TK	AA	08-Jun-11	01-Jun-11	100	53	19	1.0	1.0	1.9	893	30	31
1999	HOND	4S	M	08-Jun-11	01-Jun-11	100	24	57	1.0	0.0	0.0	893	2,456	943
1999	MAZD	CN	M	08-Jun-11	01-Jun-11	100	134	463	1.0	0.2	0.7	893	1,083	1,049
1999	VOLK	4S	BA	26-May-11	24-May-11	100	155	104	1.0	0.1	0.2	893	705	1,092
2000	VOLK	2S	K	06-May-11	02-May-11	100	134	525	1.0	0.8	3.6	893	247	508
2002	CHEV	TK	PG	13-Jun-11	02-Jun-11	100	114	128	1.0	(0.0)	0.1	893	60	425
2002	NISS	TK	BC	09-Jun-11	26-May-11	100	(4)	4	1.0	0.1	0.0	893	1,254	1,041
2003	GMC	TK	PG	13-Jun-11	02-Jun-11	100	(5)	28	1.0	0.1	0.0	893	909	2,041

Table VI-5 Third Measurements of High Emitters

				Date			HC Values				CO Values				NOx Values			
Year	**Make**	**Body Style**	**Registration County**	**Last**	**Prev**	**2nd Prev**	**Std**	**Last**	**Prev**	**2nd Prev**	**Std**	**Last**	**Prev**	**2nd Prev**	**Std**	**Last**	**Prev**	**2nd Prev**
1993	CHEV	VN	K	06-May-11	03-May-11	02-May-11	208	273	278	147	1.80	0.29	0.08	0.05	1087	1,178	334	183
1994	DODG	TK	K	06-May-11	03-May-11	02-May-11	168	201	235	257	1.80	0.52	0.53	0.40	1457	1,278	2,689	3,239
2005	MAZD	TK	CA	06-May-11	03-May-11	02-May-11	100	462	269	181	1.00	1.79	2.25	2.29	893	643	532	280

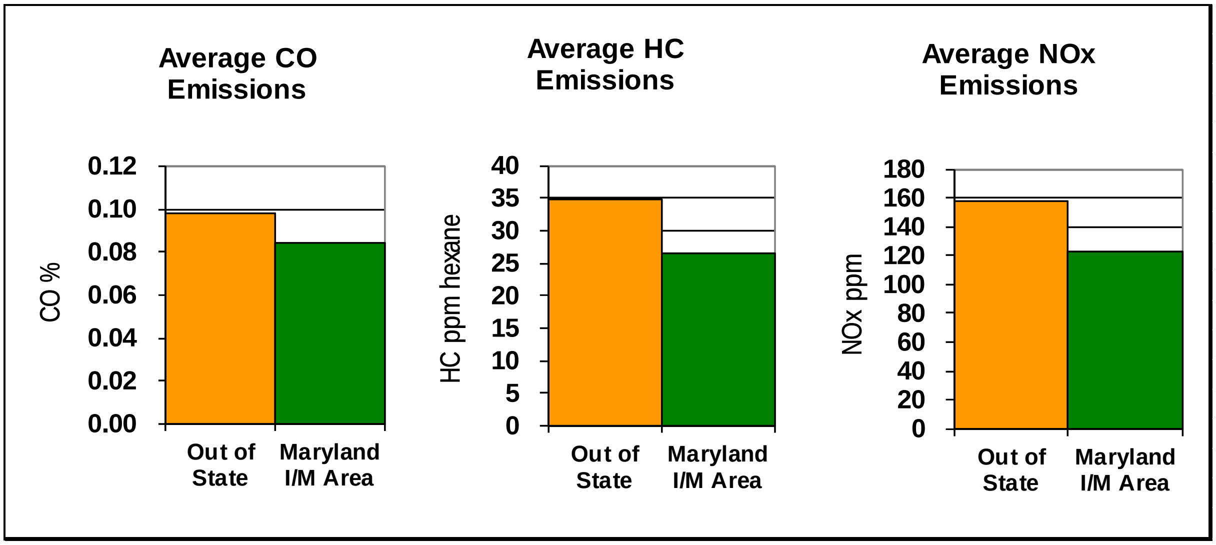
VII. Out of State Vehicles

Valid measurements were obtained on 7,017 vehicles with out of state plates. This is 11% of the surveyed vehicles with valid measurements and a visible plate. Because these vehicles are registered to other states, specific information about the type and age of these vehicles is not available as part of this survey. Compared to the surveyed vehicles registered in the Maryland I/M counties the vehicles from out-of-state had 17% higher CO, 32% higher HC and 28% higher NOx.

The Maryland vehicles on average were measured at 2% lower vehicle specific power than the out-of-state vehicles.

No conclusions can be drawn as to whether the out-of-state fleet is cleaner or dirtier for equivalent aged vehicles because the age of the out-of-state fleet is unknown. The comparative emissions are shown in Figure VII-1.

Figure VII-1 Maryland I/M and Out-of-state Vehicle Emissions

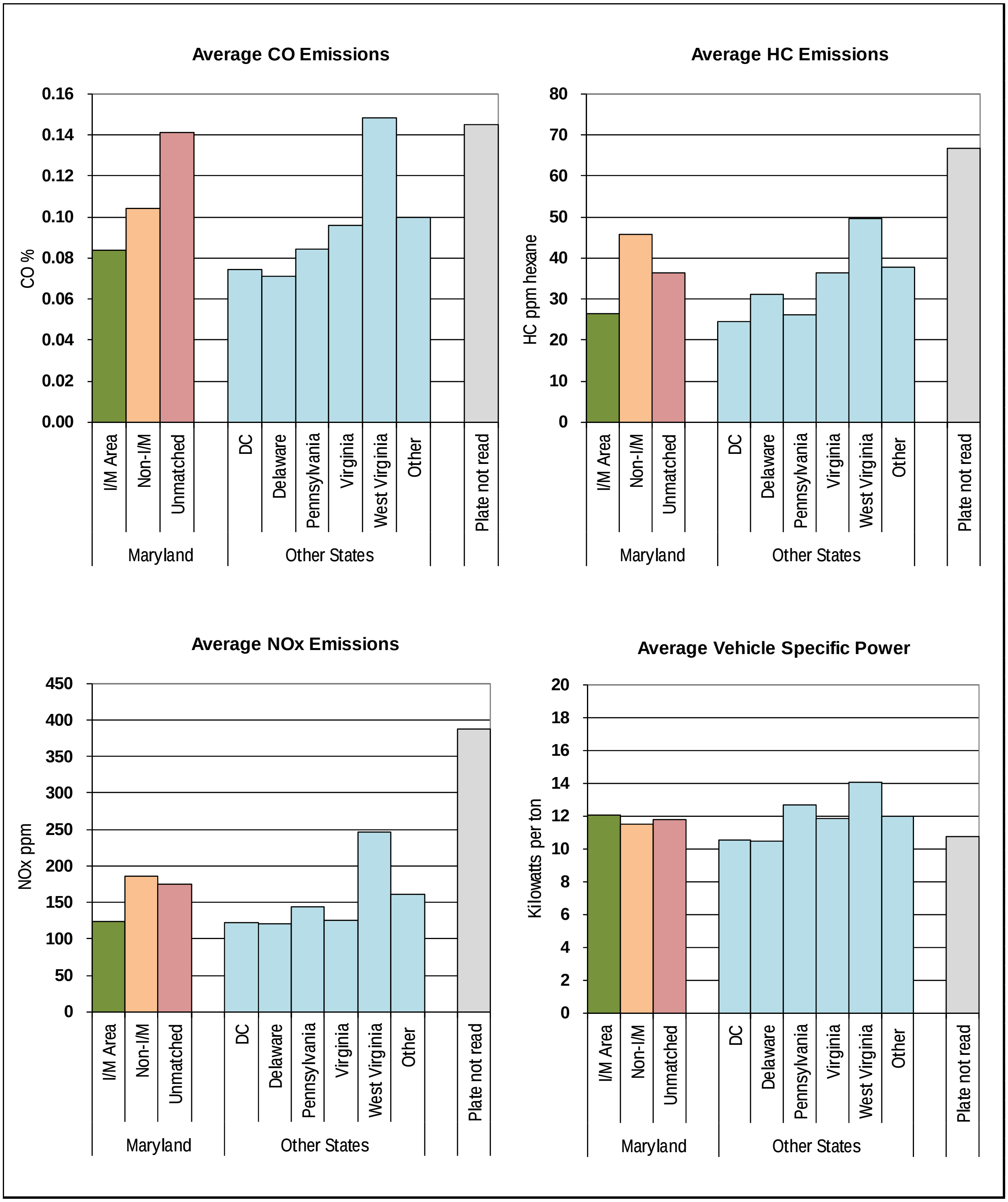


Average emissions and the average measured vehicle specific power are shown by jurisdiction in Figure VII-2. As noted in Section V, vehicles registered in Maryland counties subject to I/M had lower emissions than those registered in counties not subject to I/M. Vehicles registered in Maryland counties subject to I/M also had lower emissions than vehicles with Maryland plates that were not matched to a registration.

Vehicles from neighboring states with I/M programs had average emissions similar to those of Maryland vehicles from I/M counties. Vehicles from Virginia, which has an I/M program in its northern counties, had higher average HC and CO emissions and similar NOx. Vehicles from West Virginia, which has no I/M program, had the highest average emissions except for vehicles whose plate was not captured or could not be read.

Vehicles whose plates were not captured or could not be read may be larger vehicles such as medium-duty trucks, vehicles with tow hitches or pulling trailers and vehicles with dirty or obscured plates. These vehicles had the highest average emissions of HC and NOx.

Figure VII-2 Emissions by Plate Jurisdiction



References

1 McClintock, P. "The Colorado Enhanced I/M Program 0.5% Sample Annual Report" Prepared for the Colorado Department of Public Health and Environment, 1998.

2 Lindner, J. "Draft Guidance on Use of In-Program Data for Evaluation of I/M Program Performance" EPA, August 2001