EVALUATION OF TEST DATA COLLECTED IN 2001 AND 2002 FROM CONNECTICUT'S INSPECTION/MAINTENANCE PROGRAM

FINAL REPORT

Prepared for:

Connecticut Department of Environmental Protection

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1.0 Executive Summary

In 1983, the State of Connecticut implemented an inspection/maintenance (I/M) program. In an I/M program, vehicles are periodically inspected, and those with evidence that they exceed design emission standards must be repaired. I/M programs were mandated under the Clean Air Act in areas designated as severe non-attainment for ozone. In other states, I/M programs have been adopted as an ozone control strategy. Connecticut's I/M program was designed to identify vehicles that have been tampered or have received improper maintenance. These vehicles are required to be repaired until they comply with emission standards. The Connecticut Department of Motor Vehicles (DMV) manages the I/M program; the Connecticut Department of Environmental Protection (DEP) ensures that the program achieves the air quality benefits as outlined in Connecticut's State Implementation Plan (SIP).

The original program implemented in 1983 subjected vehicles to two inspections – an idle test where exhaust concentrations of hydrocarbons (HC) and carbon monoxide (CO) were measured while the vehicle was idling and a visual inspection for the presence of emission control devices, such as the catalytic converter.

In 1998, Connecticut substantially enhanced its existing I/M program to meet new SIP requirements. The emission test was changed from an unloaded idle emission test to a loaded-mode test (ASM2525). With this change, Connecticut began evaluating emissions of oxides of nitrogen[1] (NO_x) along with HC and CO. A loaded-mode test uses a chassis dynamometer to simulate on-road driving. In addition, the inspection includes a gas cap pressure test to check to see if the gas cap holds pressure. Leaking gas caps are a major source of evaporative HC emissions. The inspection continued to include a visual emission control component check.

In 2000, DEP with support from DMV performed a detailed analysis of data collected from the I/M program in 1999. The primary goal of this analysis

[1] Nitric oxide (NO) is measured as a surrogate for oxides of nitrogen (NO_x)

was to quantify the emission reductions resulting from Connecticut's I/M program. Another goal was to generate EPA required reports. DEP has recently updated this analysis using data collected from January 1, 2001 through July 1, 2002 at which time the program was suspended to allow for a new emission test program to be implemented. Following are the major findings of the updated analysis:

❖ During 2001, 1.21 million vehicles were tested in Connecticut's Inspection and Maintenance (I/M) program. Of this total, 97,071 vehicles (8%) failed their first (initial) I/M test. The breakdown is as follows:
  - 73,912 (6.1%) failed the ASM emission test
  - 26,024 (2.1%) failed the gas cap pressure test
  - 2,865 (0.24%) failed both the ASM and gas cap tests
  - These statistics are similar to those observed in the 1999 data.

❖ Data from the program can be used to estimate the reductions from one inspection and repair cycle. The emission reductions for one cycle will be lower than the overall reductions for the program because of the following factors:
  - Estimates do not include the effect of maintenance or repairs that were performed before the I/M test.
  - Estimates do not include benefits for the multiple inspection and repair cycles that have been performed on Connecticut's fleet.
  - Estimates do not account for vehicles that may have been retired as a result of failing the test.

❖ Based on data collected in Connecticut's I/M program, repairs to vehicles failing inspection reduce ***overall*** fleet emissions by the following percentages:
  - 31.1% for CO
  - 17.4% for HC
  - 10.6% for NOx
  - These statistics are similar to those observed in the 1999 data.

- Based on actual test lane data, emission reductions from **failing vehicles** repaired as a result of the I/M program are calculated to be:
  - 84.2% for carbon monoxide (CO)
  - 63.2% for hydrocarbons (HC)
  - 56.1% for oxides of nitrogen (NOx)
  - These statistics are similar to those observed in the 1999 data.

- Overall, 27,312 vehicles that failed the test in 2001 (28.1% of the failures) did not receive a passing result (or waiver) by June 2002. This is an improvement over 1999, indicating that DMV's efforts to boost compliance have been successful. Overall, 98% of the vehicles tested ultimately comply with standards.

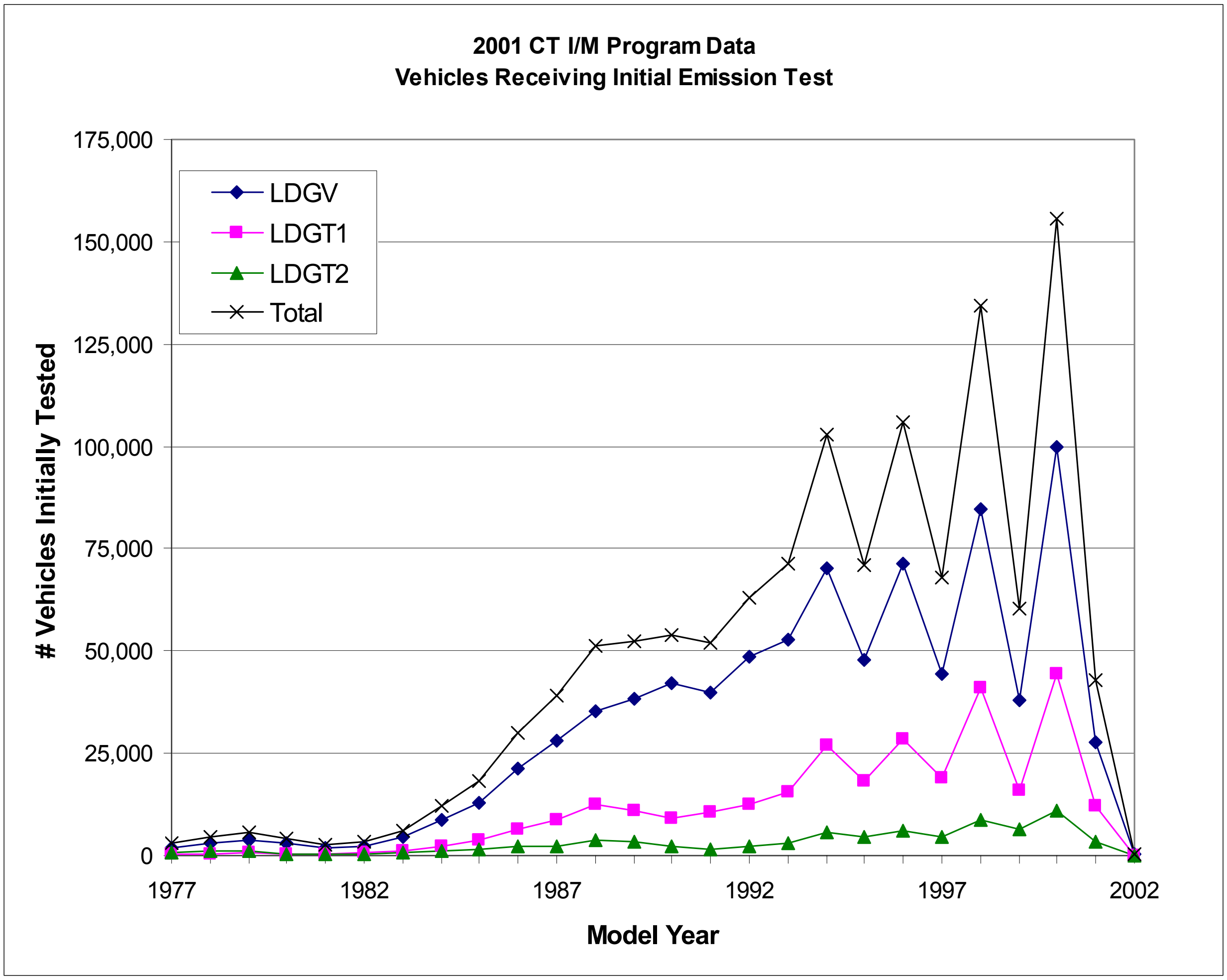
- In October 2003, a new emission test program started-up. In this program, testing is done in approximately 300 private garages. DMV and its contractor will be performing extensive quality assurance checks on the new program to assure that it meets its requirements. DEP will continue to evaluate program effectiveness using the program evaluation techniques presented in this report as a model.

- Connecticut's centralized I/M program can be used as a benchmark to evaluate other programs, including the new decentralized I/M program.

2.0 Observed Failure Rates

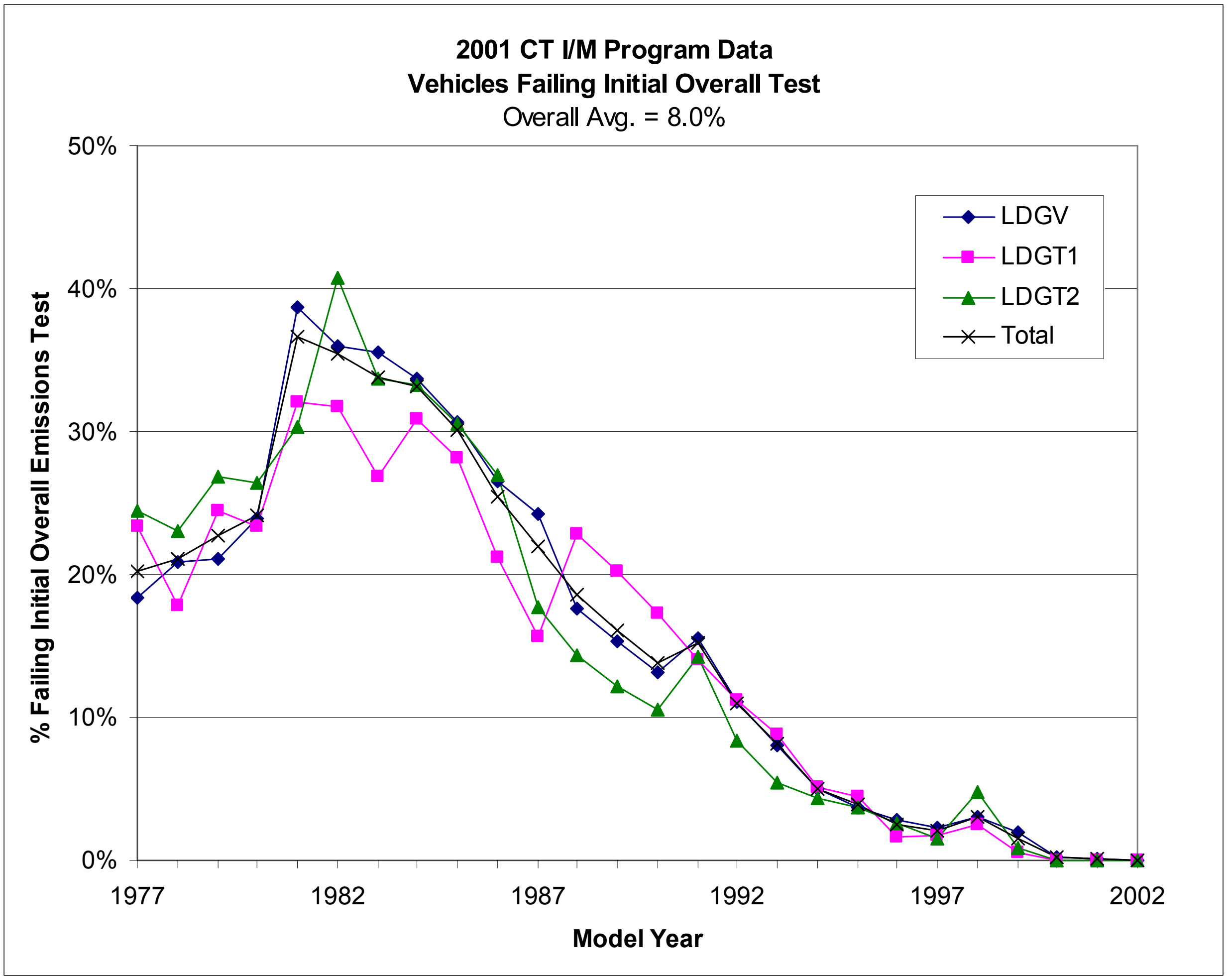
Failure rates were calculated using test results from the I/M test lanes for 2001 (1,214,411 vehicles tested).

- Overall, 97,071 vehicles (8%) failed the initial inspection.
- 73,912 (6.1%) vehicles failed the initial ASM test.
- The chart on the next page shows the initial failure rate by model year. Other I/M programs (NJ, CA, GA, VA) using ASM tests report similar failure rates.
- Overall, 59.6% of the vehicles failing the initial ASM test passed the first retest.
- 26,024 (2.1%) vehicles failed the gas cap test, which is similar to failure rates observed in other programs.
- Overall, 98% of the vehicles failing the initial gas cap test passed the first retest.
- 2,865 (0.24%) failed both the ASM and gas cap tests.
- Trends for 2002 were nearly identical to those for 2001.



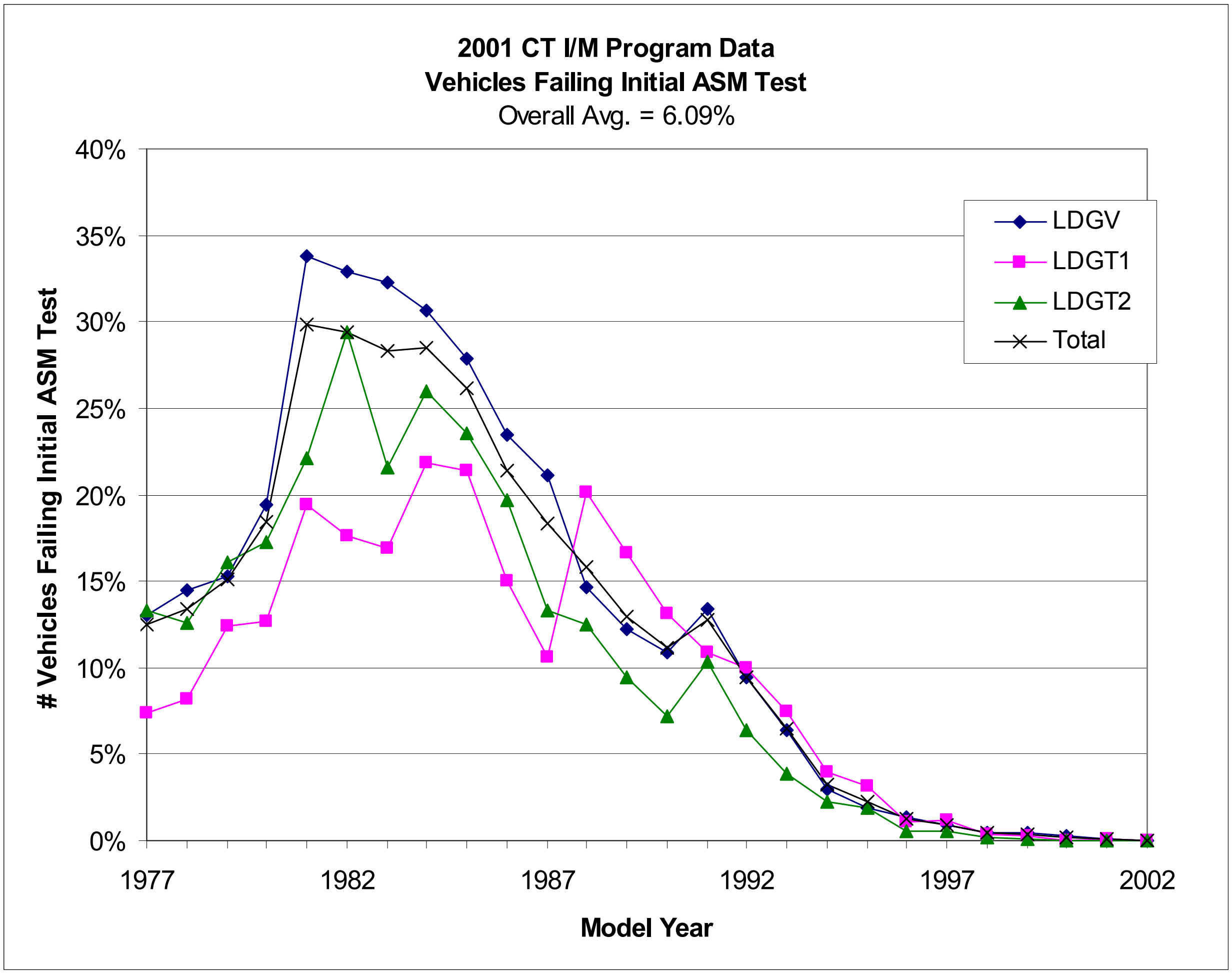
This chart shows the total number of inspections by model year. The fluctuations reflect the biennial nature of the program.

LDGV = Light-duty gasoline powered vehicles (Passenger Cars)
LDGT(1&2) = Light-duty gasoline powered trucks



This chart shows the overall percent of vehicles that fail the tailpipe test, gas cap test, or visual emission control component inspection. As expected, the failure rate is lowest for new vehicles.

LDGV = Light-duty gasoline powered vehicles (Passenger Cars)
LDGT(1&2) = Light-duty gasoline powered trucks



This chart shows failure rates by model year for the ASM test. The average ASM test failure rate for all vehicles was 6.1%.

Typically, you expect a higher failure rate for older model year vehicles. The peak that occurs in 1981 is expected; these were the first vehicles to use computerized emission control systems and they experienced frequent failures of the emission control system.

LDGV = Light-duty gasoline powered vehicles (Passenger Cars)
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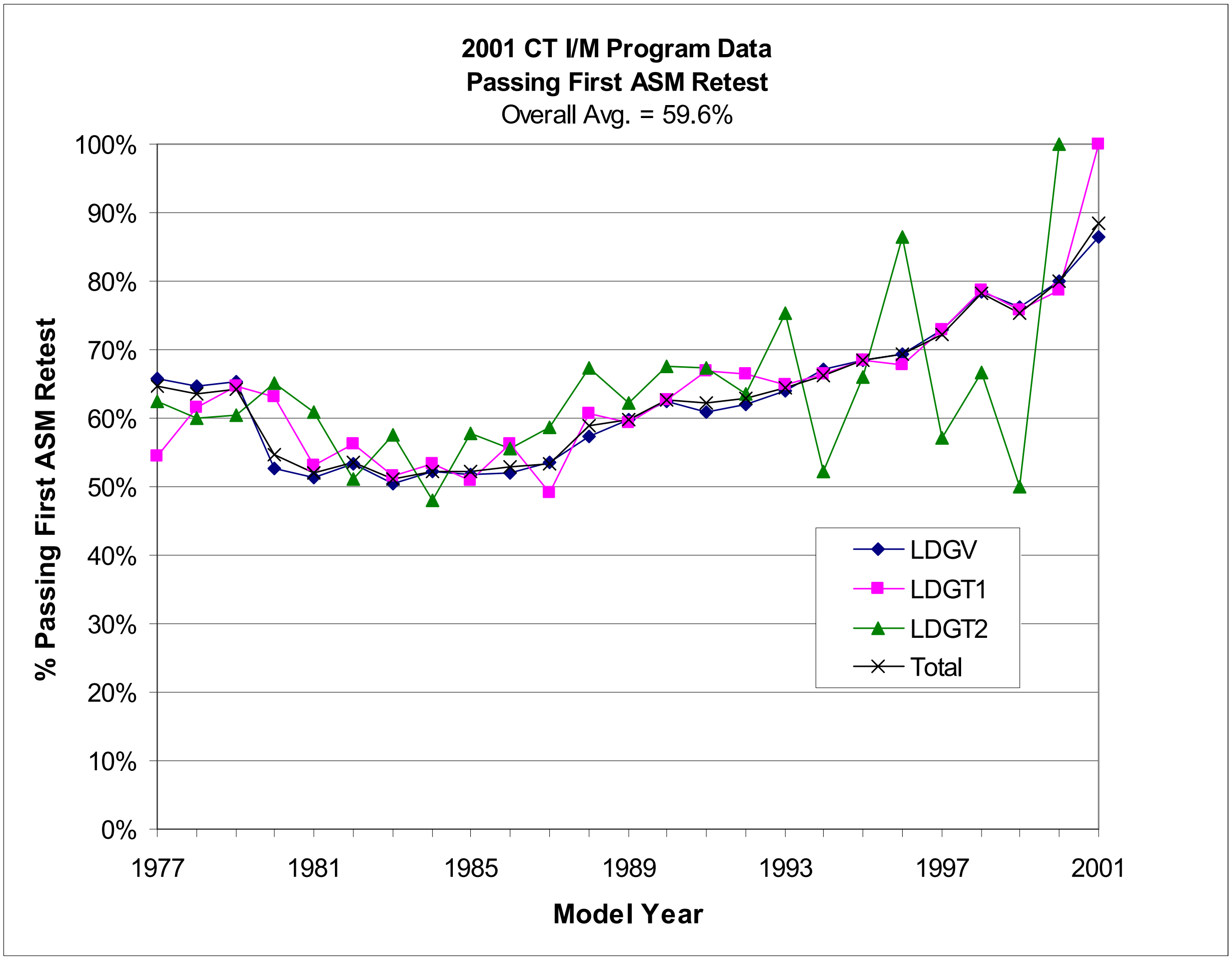

This chart shows the percent of vehicles by model year that pass their first ASM retest. The retest pass rate is lowest for the older vehicles. Overall, 59.6% of the vehicles pass the first ASM retest. It appears that many vehicles are receiving inadequate diagnosis of the problem(s) causing high emissions.

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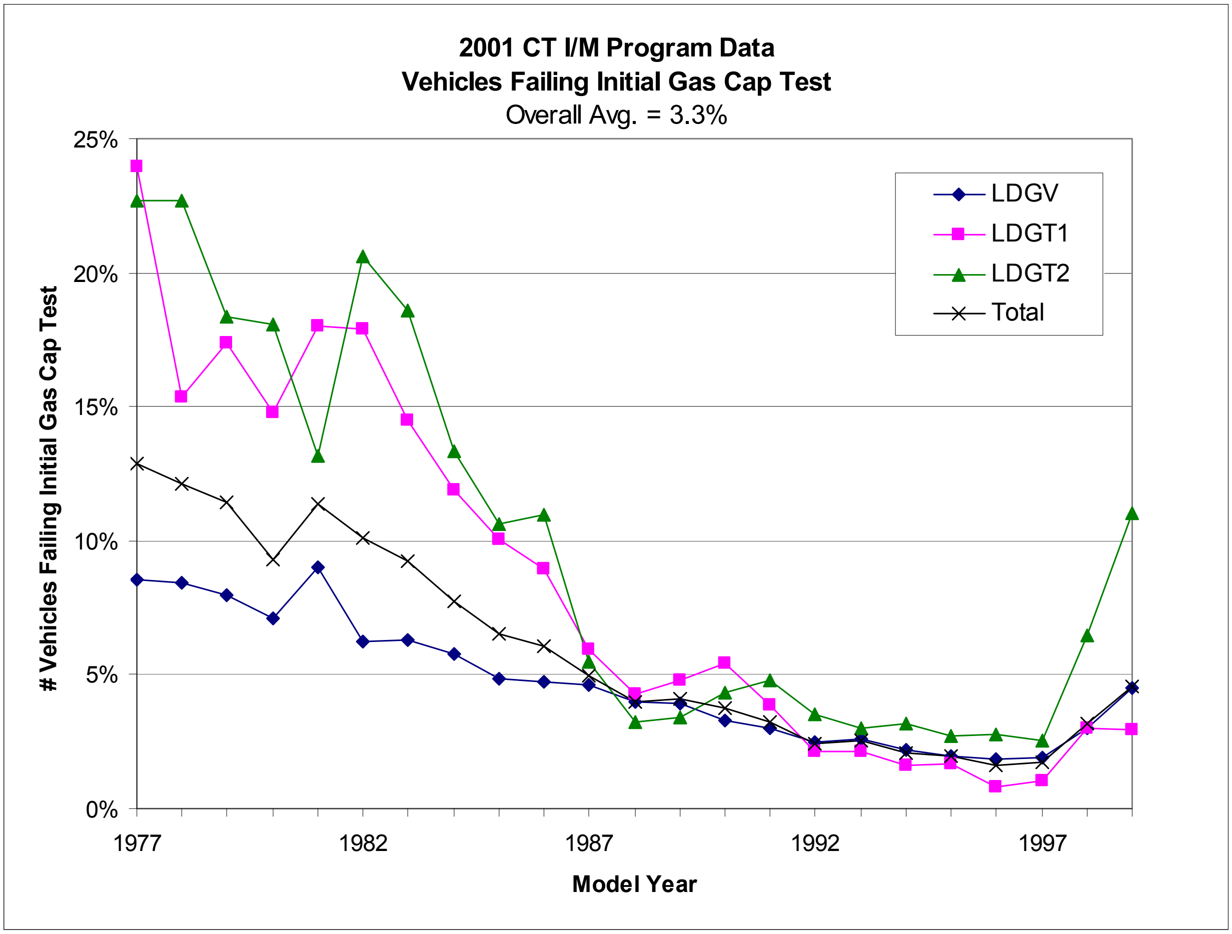
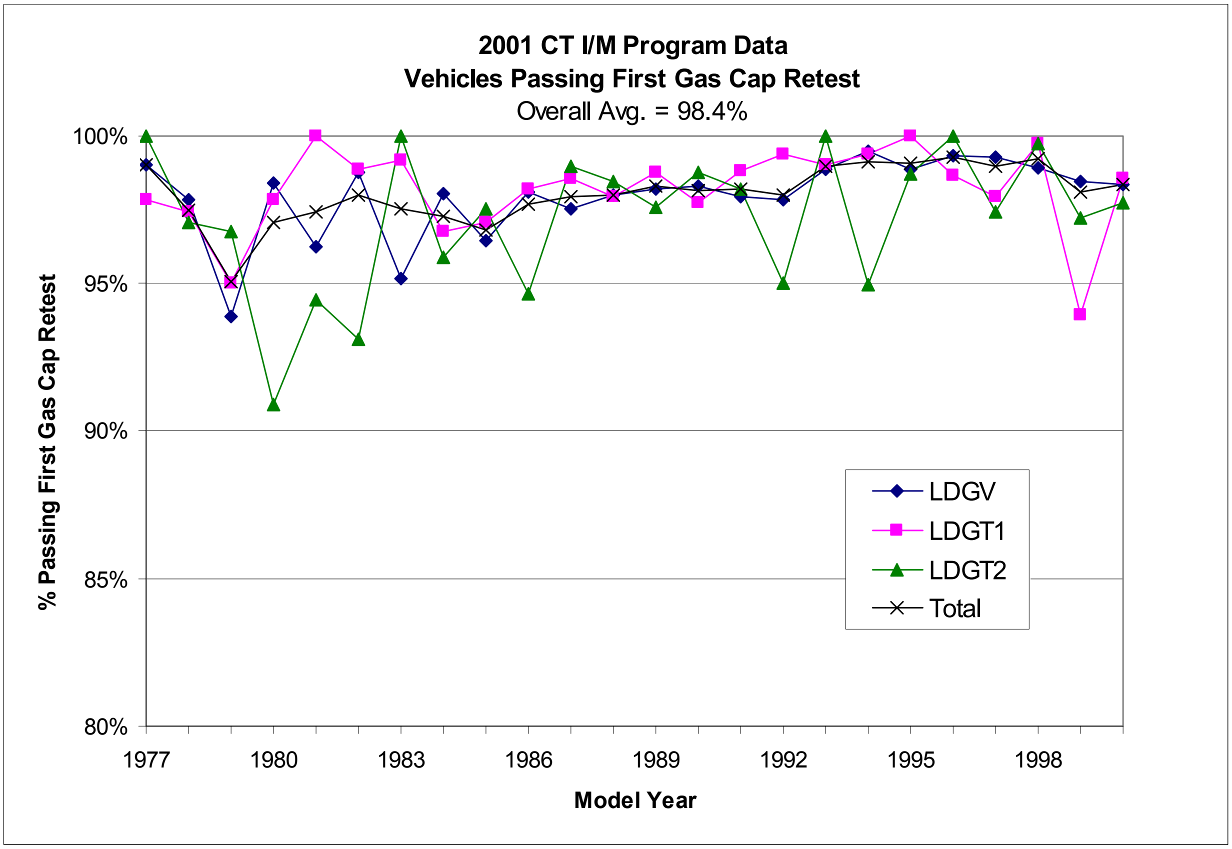
LDGT(1&2) = Light-duty gasoline powered trucks



This chart shows the gas cap pressure test failure rate by model year. As with the ASM test, the failure rate is higher for older vehicles.

LDGV = Light-duty gasoline powered vehicles (Passenger Cars)
LDGT(1&2) = Light-duty gasoline powered trucks



This chart shows the gas cap retest pass rate by model year. Overall, 98% of the vehicles failing the initial gas cap pressure test pass their retest. These vehicles likely received new gas caps.

LDGV = Light-duty gasoline powered vehicles (Passenger Cars)
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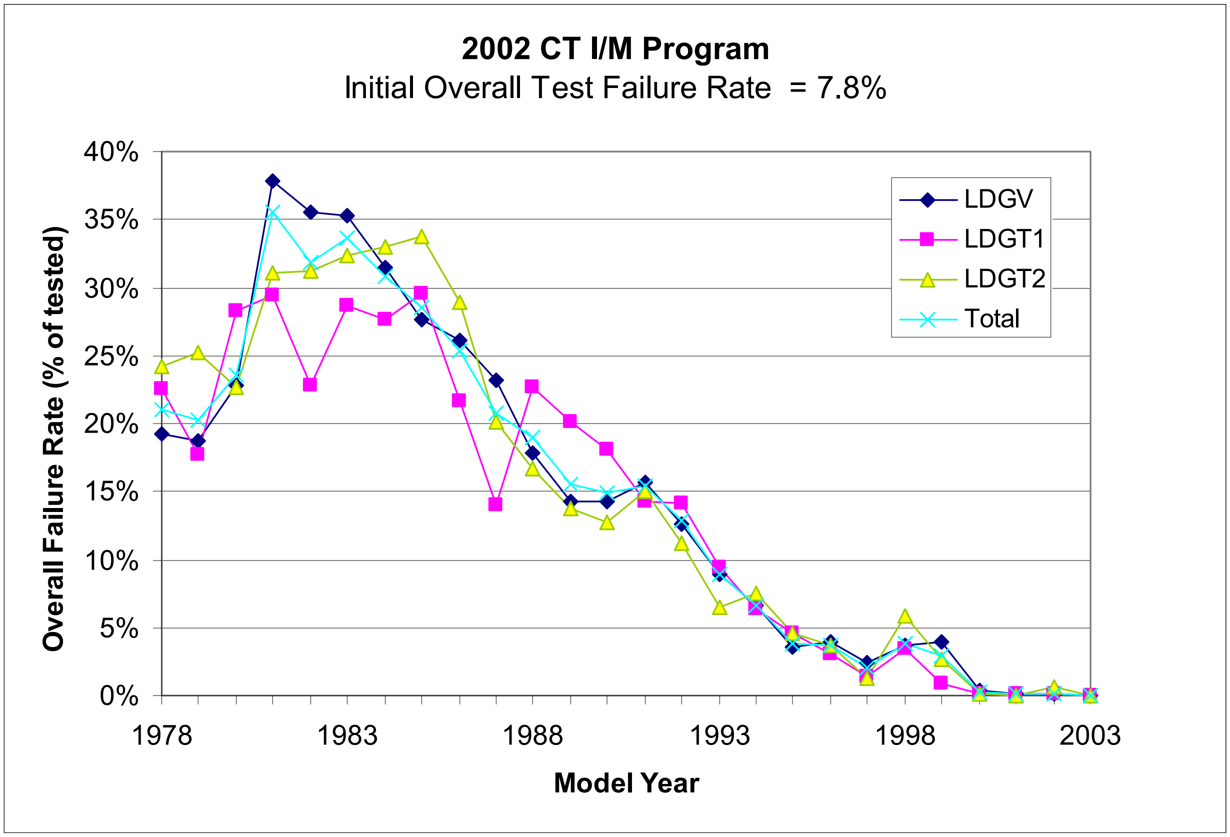

This chart shows the overall percent of vehicles that fail the tailpipe test, gas cap test, or visual emission control component inspection in 2002. The trends are nearly identical to those for 2001.

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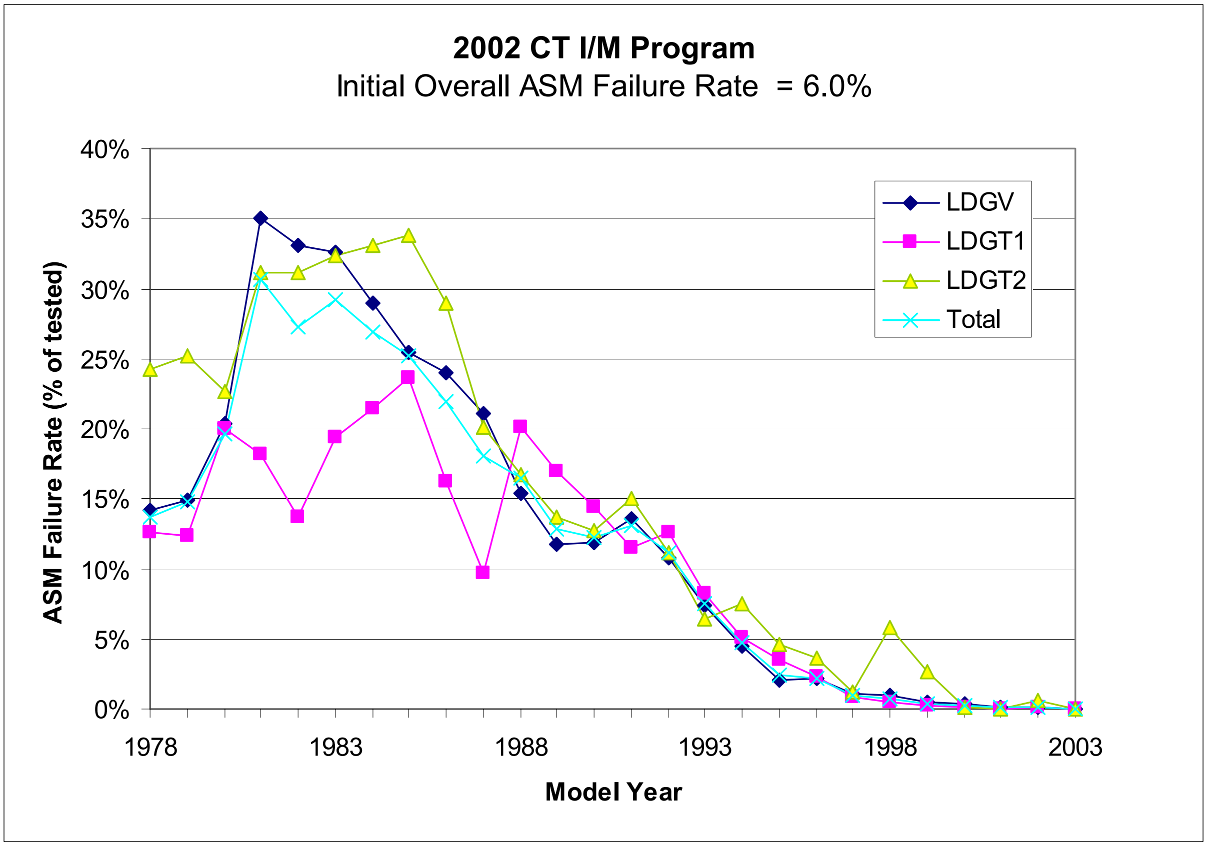

This chart shows failure rates in 2002 by model year for the ASM test. The average ASM test failure rate for all vehicles was 6.1%.

The trends are nearly identical to those for 2001.

LDGV = Light-duty gasoline powered vehicles (Passenger Cars)
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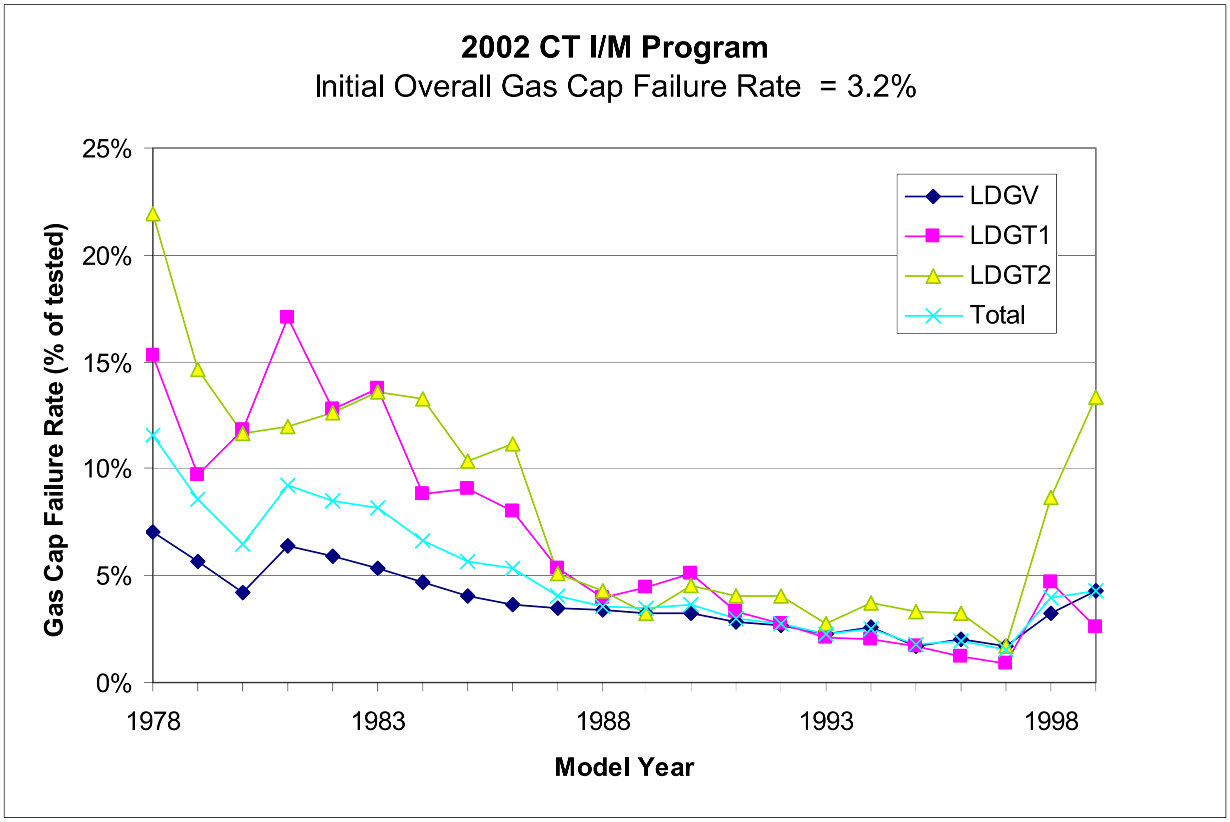

This chart shows the gas cap pressure test failure rate in 2002 by model year. As with the ASM test, the failure rate is higher for older vehicles. The trends are nearly identical to those for 2001. The increased failure rate for the 1998 and 1999 models is a concern; it could be due to false failures because the test equipment did not have correct adapters[2].

LDGV = Light-duty gasoline powered vehicles (Passenger Cars)
LDGT(1&2) = Light-duty gasoline powered trucks

[2] Adapters simulate the tank fillerneck. Adapters are the most critical components of gas cap testers.

3.0 Enforcement of Connecticut’s I/M Program

Fate of Failed Vehicles

Enforcement of Connecticut’s I/M program was assessed by analyzing the fate of failed vehicles, i.e. what happens to vehicles failing their inspection? A central question is whether these vehicles ultimately pass the test. The fate of vehicles failing the I/M test in 2001 was evaluated. Failures in 2001 were tracked throughout 2001 and for the first 6 months in 2002.

Of the 97,071 vehicles that failed the test in 2001, 27,312 (28.1% of the failures) did not receive a passing result (or waiver) by June 2002. This was an improvement over the 31.4% no pass rate found by June 2000 for vehicles tested in 1999. This indicates that DMV’s efforts to boost compliance have been successful. Of the vehicles failing the test, a greater percentage of older vehicles than newer vehicles never pass the test. These vehicles are either registered in other states, retired or operating illegally in Connecticut. Overall, 98% of the vehicles tested ultimately comply with standards.

2001 CT I/M Program Data
Vehicles with No Known Outcome

Model Year	No Known Outcome (# vehicles / % of failing initial test)							
	LDGV		LDGT1		LDGT2		Total	
1977	124	32.5%	22	27.8%	67	42.4%	213	34.5%
1978	166	27.9%	16	20.3%	70	26.7%	252	26.9%
1979	215	27.4%	42	25.9%	99	30.1%	356	27.9%
1980	244	32.5%	31	28.4%	38	33.9%	313	32.2%
1981	279	38.7%	59	33.1%	24	38.1%	362	37.6%
1982	351	40.7%	69	31.1%	30	32.3%	450	38.2%
1983	655	41.3%	97	31.1%	77	37.0%	829	39.3%
1984	1,243	42.0%	243	33.1%	143	44.4%	1,629	40.5%
1985	1,575	39.6%	398	37.3%	178	36.8%	2,151	38.9%
1986	2,193	38.8%	425	31.4%	172	29.3%	2,790	36.7%
1987	2,515	37.0%	426	31.1%	143	34.9%	3,084	35.9%
1988	2,088	33.7%	891	31.3%	169	32.3%	3,148	32.9%
1989	1,799	30.7%	661	30.2%	116	29.4%	2,576	30.5%
1990	1,564	28.1%	398	24.8%	56	22.5%	2,018	27.2%
1991	1,701	27.5%	363	24.3%	48	22.2%	2,112	26.8%
1992	1,252	23.3%	308	22.0%	36	19.0%	1,596	22.9%
1993	901	21.2%	312	22.7%	37	22.7%	1,250	21.6%
1994	540	15.5%	237	17.1%	49	19.2%	826	16.1%
1995	296	16.6%	145	17.8%	31	18.2%	472	17.0%
1996	272	13.3%	80	17.1%	16	10.2%	368	13.8%
1997	122	11.9%	30	8.9%	14	20.3%	166	11.6%
1998	175	6.7%	52	5.2%	21	5.1%	248	6.1%
1999	39	5.2%	8	9.5%	5	9.1%	52	5.8%
2000	38	15.6%	2	12.5%	0	0.0%	40	15.3%
2001	10	30.3%	1	16.7%	0	0.0%	11	28.2%
Total	**20,357**	**28.9%**	**5,316**	**25.7%**	**1639**	**27.9%**	**27312**	**28.1%**

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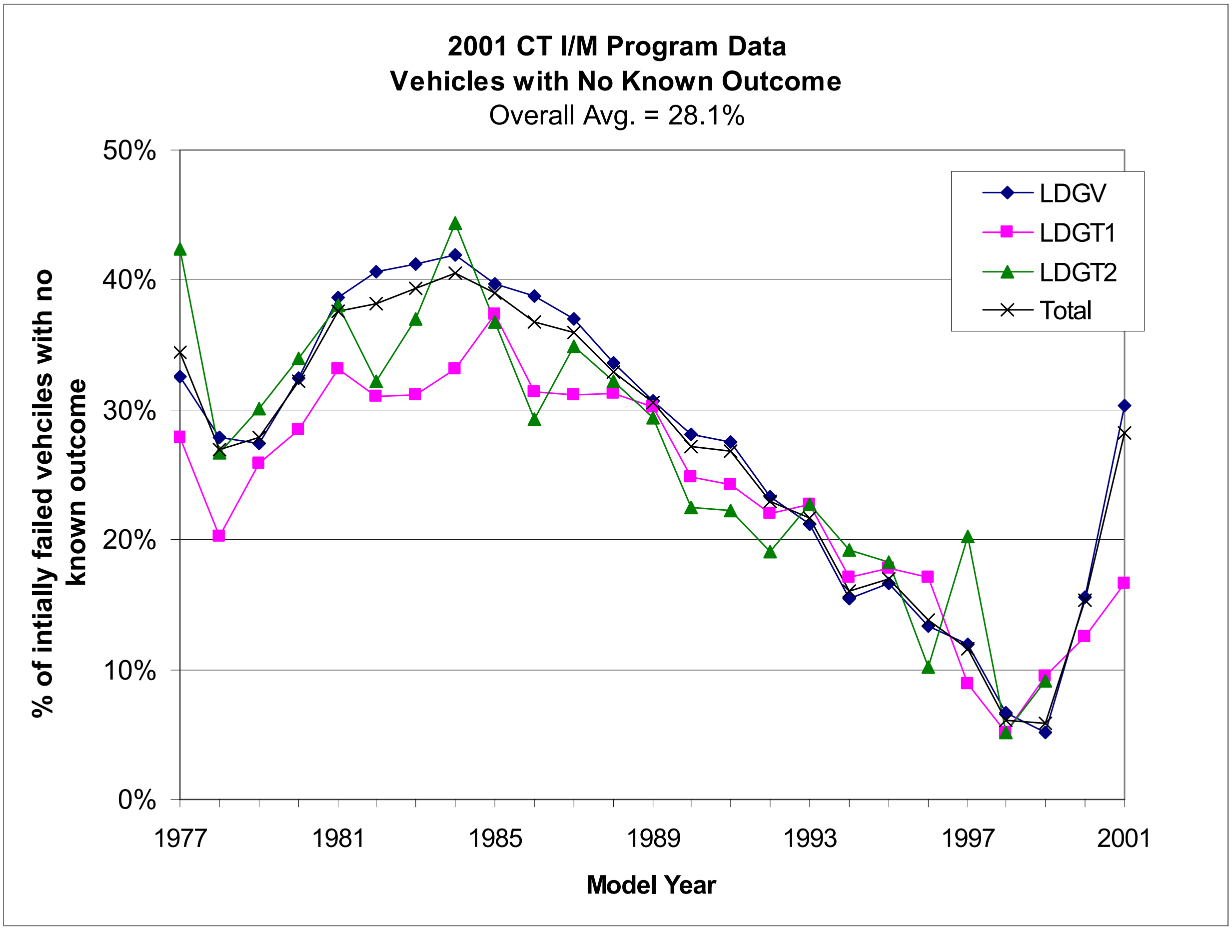

This chart shows the percentage of vehicles that fail the emission test that never ultimately pass. A greater percentage of older vehicles than newer vehicles fall into this category. Due to small number of 1998 and newer vehicles that failed the test, the increase for these years is not significant.

LDGV = Light-duty gasoline powered vehicles (Passenger Cars)
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Results of Sticker Surveys

- In the past, DMV conducted surveys of parked vehicles to determine what percent have valid I/M stickers. Data from sticker surveys provide a good indication of the percent of vehicles that were complying with I/M requirements.

- Sticker surveys were performed by DMV in 2001 and 2002 to characterize enforcement trends
  - In 2001, DMV surveyed 41,655 vehicles
  - In 2002, DMV surveyed 75,567 vehicles

- In 2001, 91% were in compliance with the I/M program. 9% of the vehicles had expired, fail or missing stickers.

- In 2002, 94.9% were in compliance with the I/M program. 5.1% of the vehicles had expired, fail or missing stickers.

- Breakdown of expired stickers:

2001:

Total	0-30	31-60	61-90	91-120	121-150	151-180	180+	No Sticker	Void
3751	218	440	366	283	238	223	1691	289	3
%	5.8%	11.7%	9.8%	7.5%	6.3%	6.0%	45.1%	7.7%	0.1%

2002:

Total	0-30	31-60	61-90	91-120	121-150	151-180	181+	No Sticker	Void
3,841	259	346	480	382	300	210	1504	329	31
%	6.7%	9.0%	12.5%	9.9%	7.8%	5.5%	39.2%	8.6%	0.8%

4.0 Observed Emission Reductions from Repairs to Failed Vehicles

Emission reductions for one inspection and repair cycle were estimated based on observed ASM emission rates before and after vehicles received their I/M test.

Before I/M rates equal the observed average of passing and failing vehicles in the as received condition.

After I/M rates equal the sum of the following divided by the number of vehicles tested:

- # Passing initial test x average initial test emission rate for passing vehicles. Passing emission rates are adjusted for the fast-pass effect.
- # Passing retest x average retest emission rate for passing vehicles.
- # that never pass (continue to fail) x average failing vehicle emission rate. (We assume that vehicles that never pass the test emit at the same rate as failing vehicles of the same model year.)
- Calculations assume that 28% of the failed vehicles never pass the test, based on the observed no-pass rate.

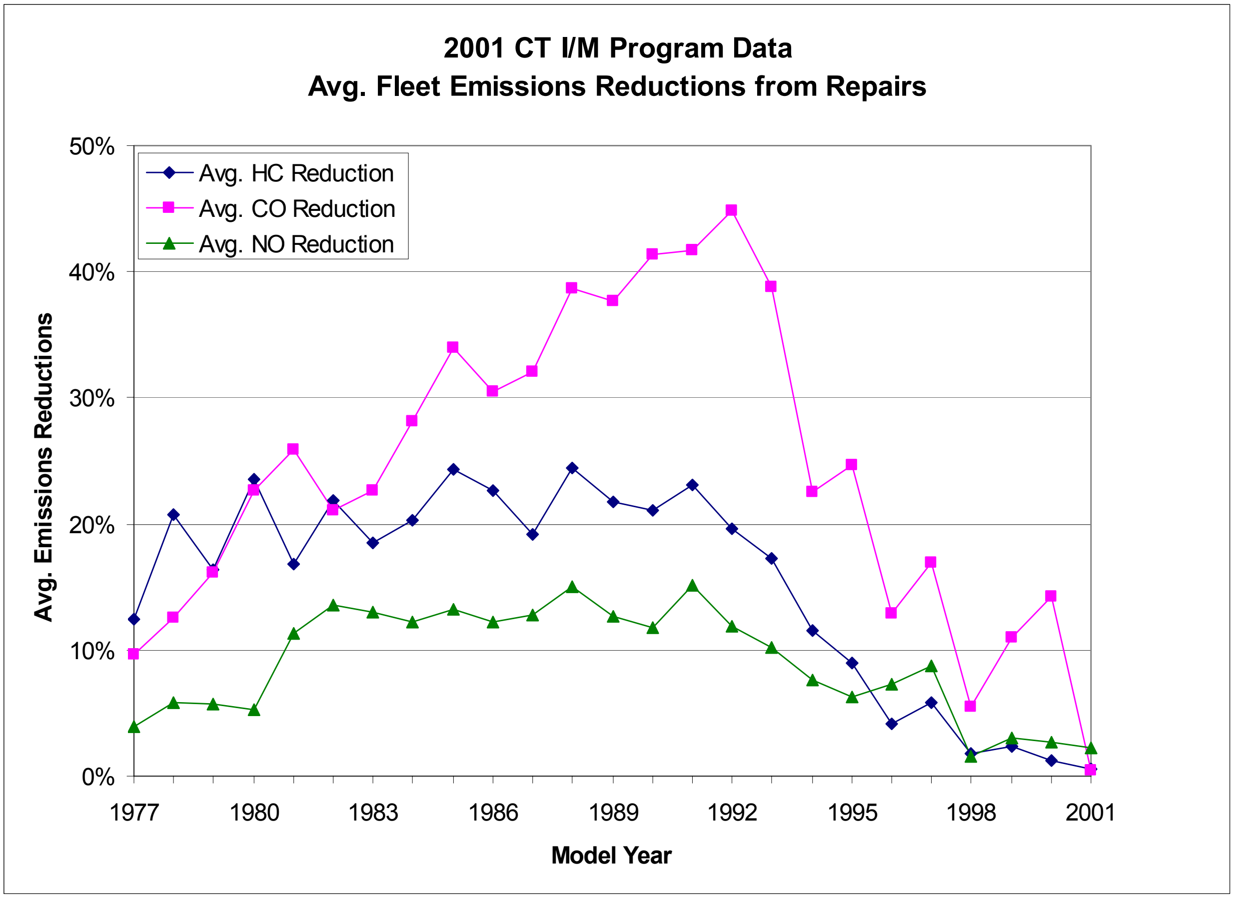
One inspection and repair cycle reduces exhaust emissions from light-duty cars and trucks by the following:

- CO – 31.1%
- VOC – 17.4%
- NOx – 10.6%

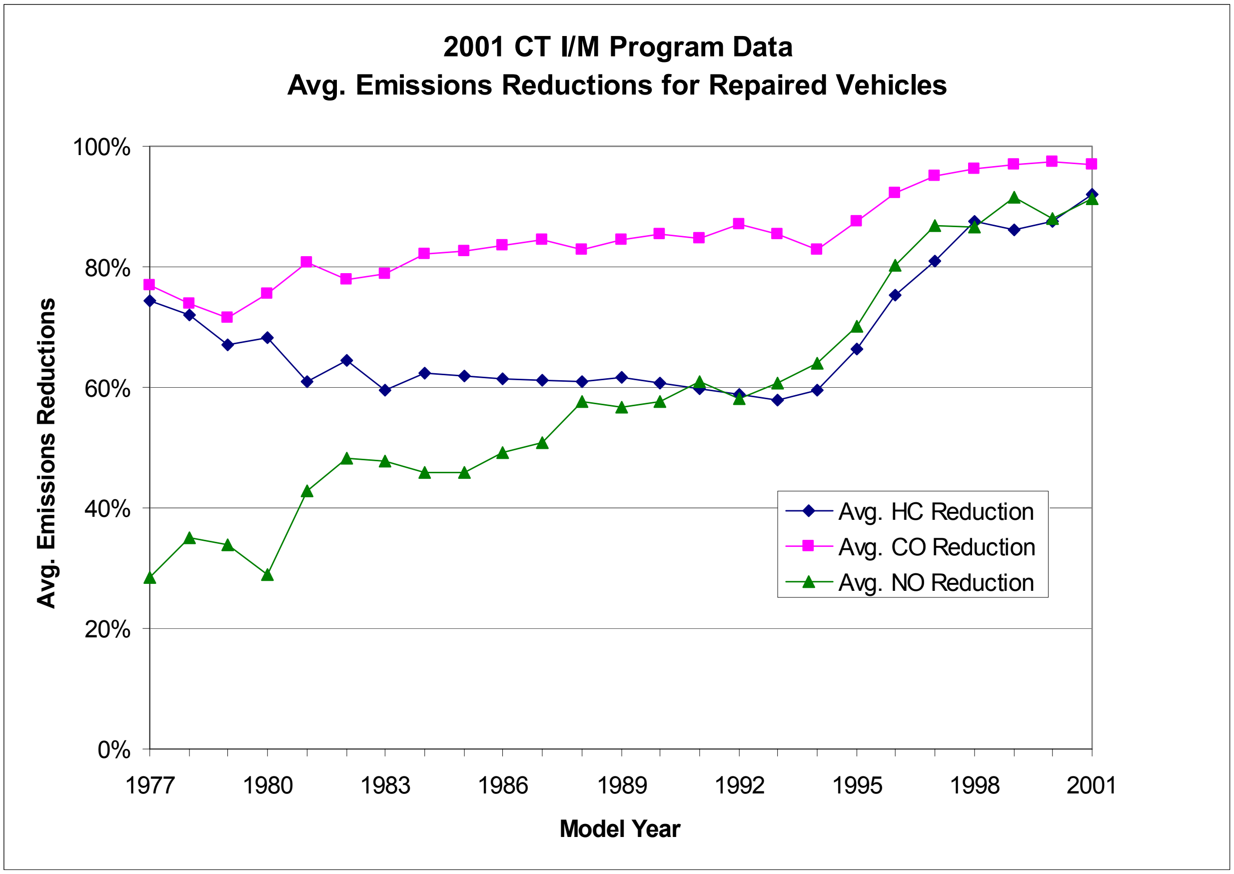
The above reductions are slightly higher than the reductions observed in the 1999 data.

Percent Reductions from Repairs to Failed Vehicles

Year	Fleet % Reduction			% Reduction -- Failed Vehicles Only		
	HC	CO	NO	HC	CO	NO
1977	12.4%	9.6%	3.9%	74.3%	76.8%	28.4%
1978	20.7%	12.6%	5.8%	71.9%	73.9%	35.1%
1979	16.3%	16.2%	5.7%	67.0%	71.6%	33.9%
1980	23.6%	22.6%	5.2%	68.2%	75.5%	28.9%
1981	16.9%	25.9%	11.3%	61.0%	80.8%	42.7%
1982	21.9%	21.0%	13.6%	64.4%	77.9%	48.2%
1983	18.5%	22.6%	13.0%	59.6%	78.8%	47.9%
1984	20.3%	28.1%	12.2%	62.4%	82.2%	45.8%
1985	24.3%	34.0%	13.2%	61.9%	82.7%	45.8%
1986	22.6%	30.5%	12.2%	61.5%	83.6%	49.2%
1987	19.2%	32.1%	12.7%	61.1%	84.4%	50.9%
1988	24.5%	38.7%	15.0%	61.0%	82.8%	57.7%
1989	21.8%	37.7%	12.6%	61.5%	84.4%	56.7%
1990	21.1%	41.4%	11.8%	60.7%	85.4%	57.7%
1991	23.1%	41.8%	15.2%	59.7%	84.7%	60.9%
1992	19.6%	44.8%	11.8%	58.9%	87.1%	58.0%
1993	17.3%	38.8%	10.2%	57.8%	85.5%	60.6%
1994	11.5%	22.5%	7.7%	59.4%	82.7%	64.0%
1995	9.0%	24.6%	6.2%	66.4%	87.6%	70.2%
1996	4.2%	12.9%	7.3%	75.4%	92.3%	80.2%
1997	5.8%	16.9%	8.8%	80.9%	95.0%	86.8%
1998	1.8%	5.5%	1.5%	87.5%	96.2%	86.5%
1999	2.3%	11.0%	3.0%	86.1%	96.9%	91.5%
2000	1.2%	14.3%	2.7%	87.4%	97.3%	88.0%
2001	0.6%	0.5%	2.2%	74.3%	76.8%	28.4%
ALL	**17.4**	**31.1**	**10.6%**	**63.2%**	**84.2%**	**56.1%**



This chart shows percent reduction in fleet emissions by model year. Emissions reductions occur from repairs to vehicles that failed in 2001. Reductions are greatest for carbon monoxide (CO), followed by hydrocarbons (HC) and oxides of nitrogen (NOx). The newest model years show the lowest emission reductions.



This chart shows the percent reductions from repairing failing vehicles in 2001. Generally, large emission reductions are shown for all three pollutants and all model year vehicles.

5.0 1999 to 2001 Inspection Cycle Analysis

A dataset of vehicles tested in 1999 and 2001 was developed. Our goal was to determine the durability of repairs performed on vehicles failing in 1999.

Failure rates (overall, by test type and by model year) in 2001 were determined for the following groups of vehicles that were tested in 1999:

- Passed initial test in 1999
- Failed initial test passed retest in 1999
- Failed initial test and never passed retest in 1999

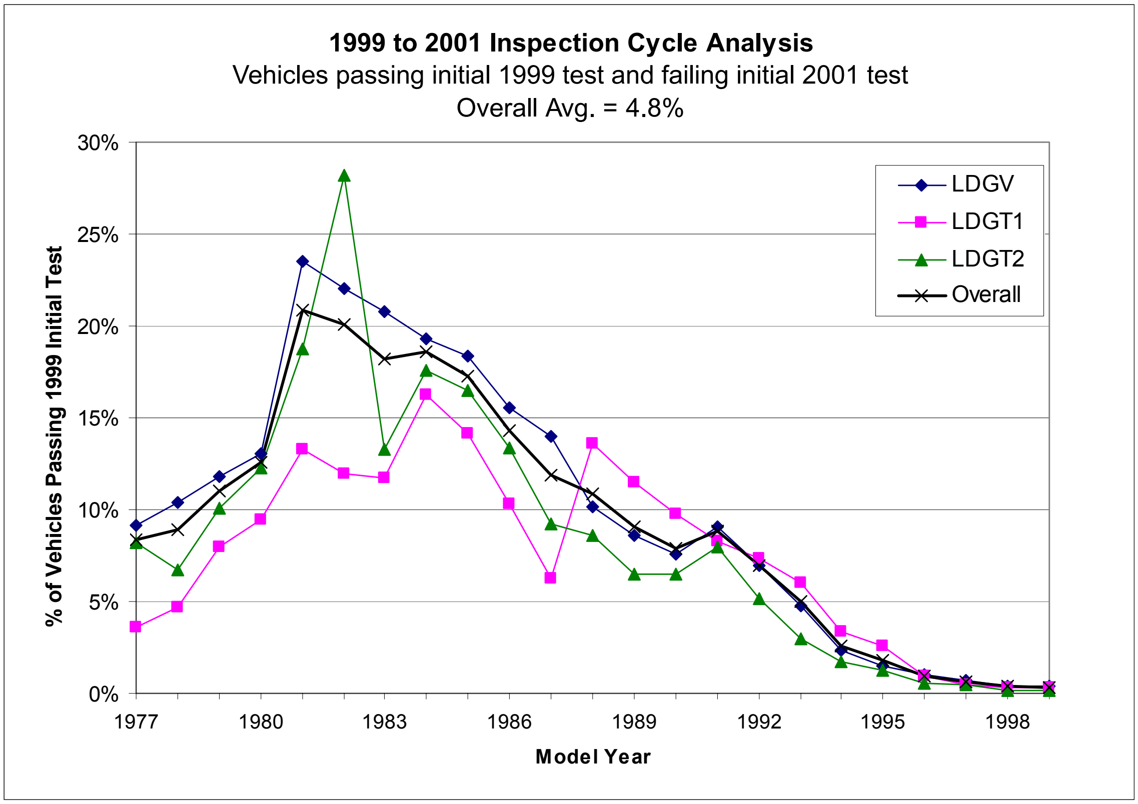
The failure rate was very low (4.8%) for the sample of vehicles that passed their initial test in 1999.

The failure rates were very high for the samples of vehicles that failed in 1999 and were repaired to pass (34%) and failed and never passed (51%). This indicates that repair quality could be greatly improved.

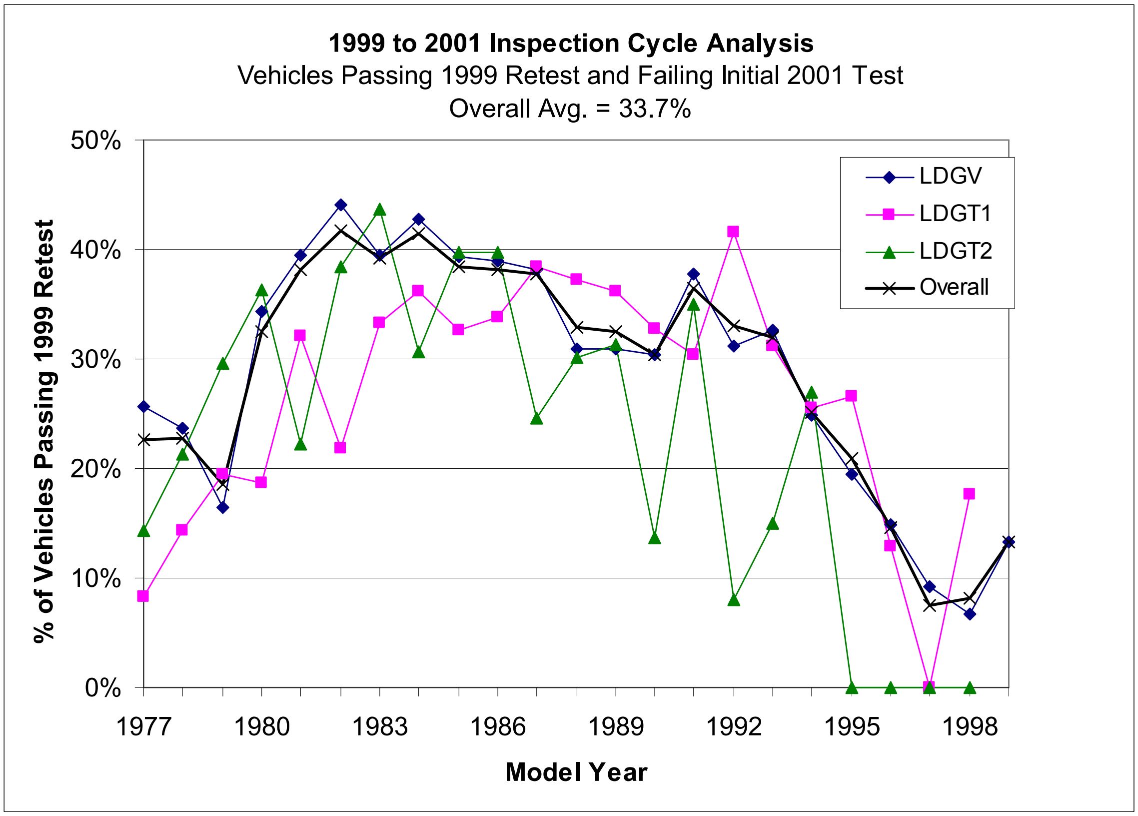
Average emission rates (overall and by model year) in 1999 and 2001 were calculated for vehicles for the following groups:

- Passed initial test in 1999
- Failed initial test passed retest in 1999
- Failed initial test and never passed retest in 1999

From this we can project how much emissions increase over the two year cycle. Emissions were significantly higher two years later for the groups that passed their initial test in 1999 or failed and were repaired to pass in 1999. The group that failed and never passed in 1999 showed lower slightly lower emission levels, indicating that some emission related repairs were performed between 1999 and 2001.



This chart shows failure rates in 2001 for vehicles that passed their initial test in 1999. The overall fail rate is 4.8% or about half the fail rate for the complete dataset.



This chart shows failure rates in 2001 for vehicles that failed their initial test in 1999 and were repaired to pass. The overall fail rate is 34% or about 4x the fail rate for the complete dataset. This indicates that failing vehicles are likely to fail again.

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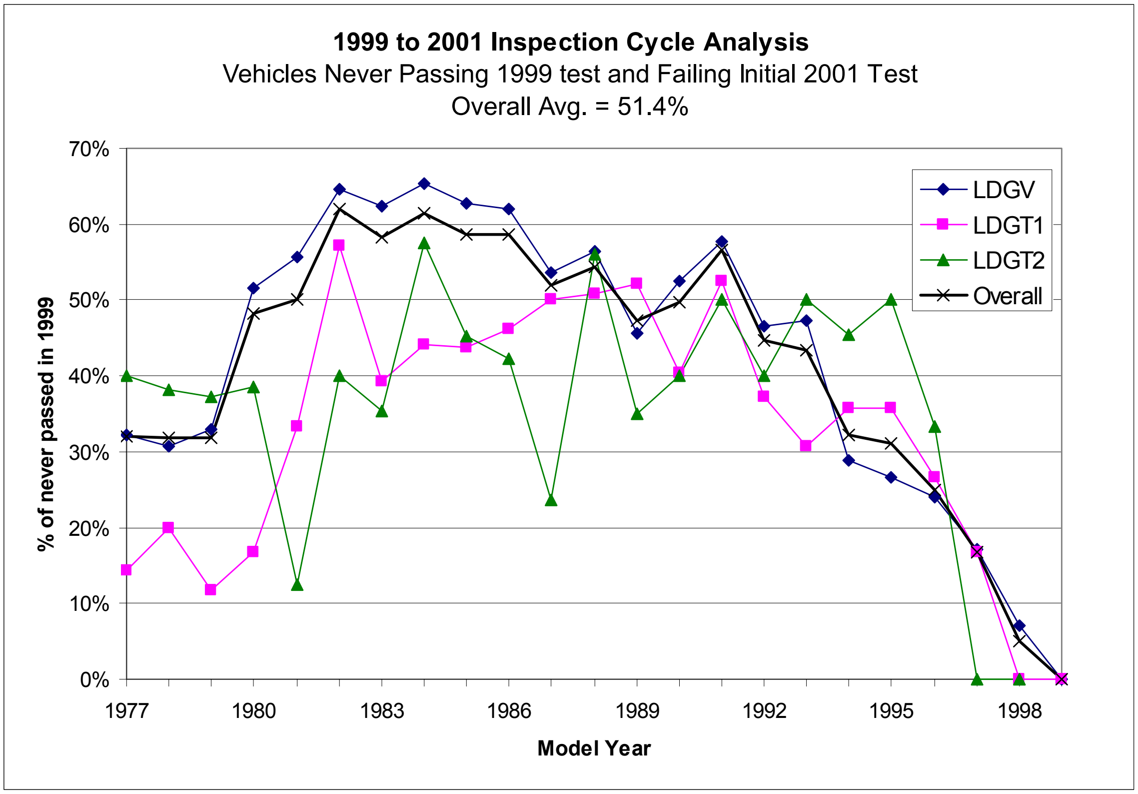

This chart shows failure rates in 2001 for vehicles that failed their initial test in 1999 and never passed. The overall fail rate is 51% or about 6x the fail rate for the complete dataset. This indicates that these vehicles have serious emission related problems.

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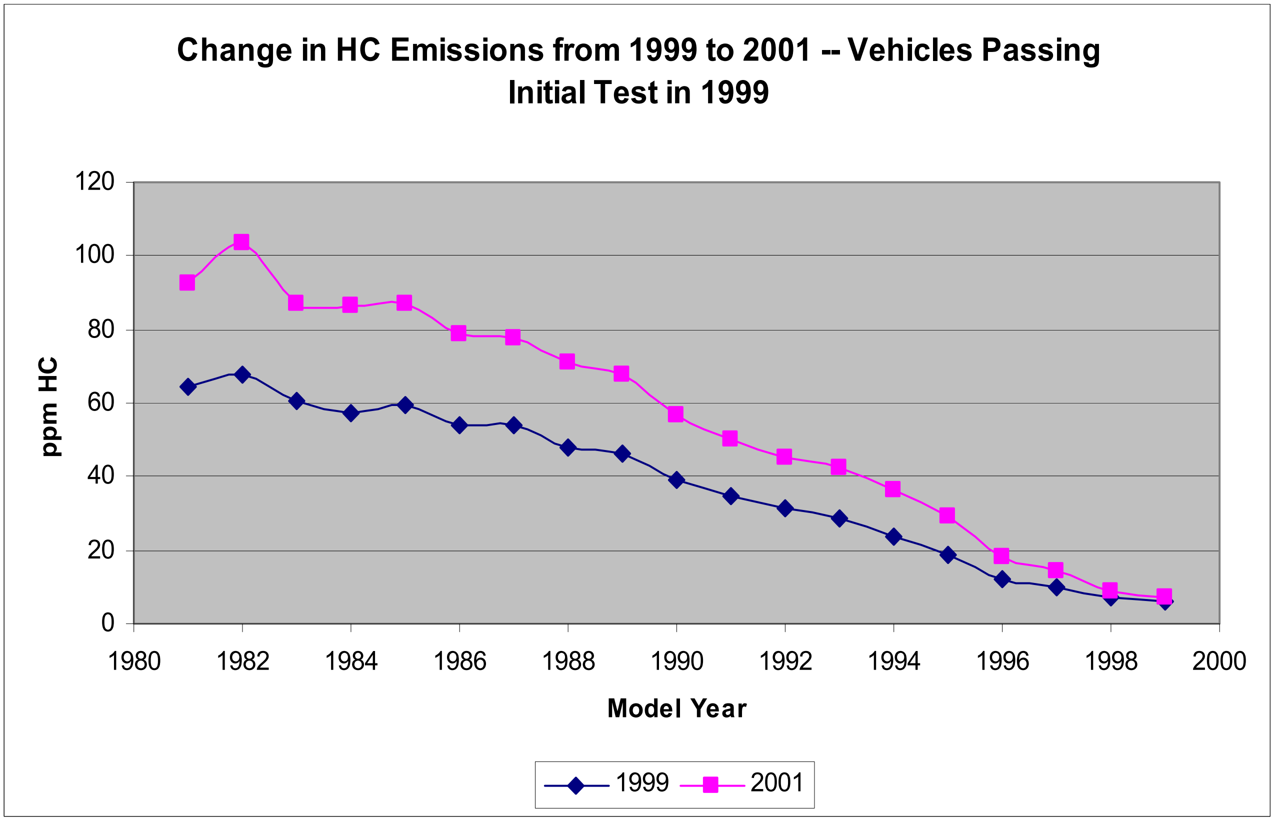
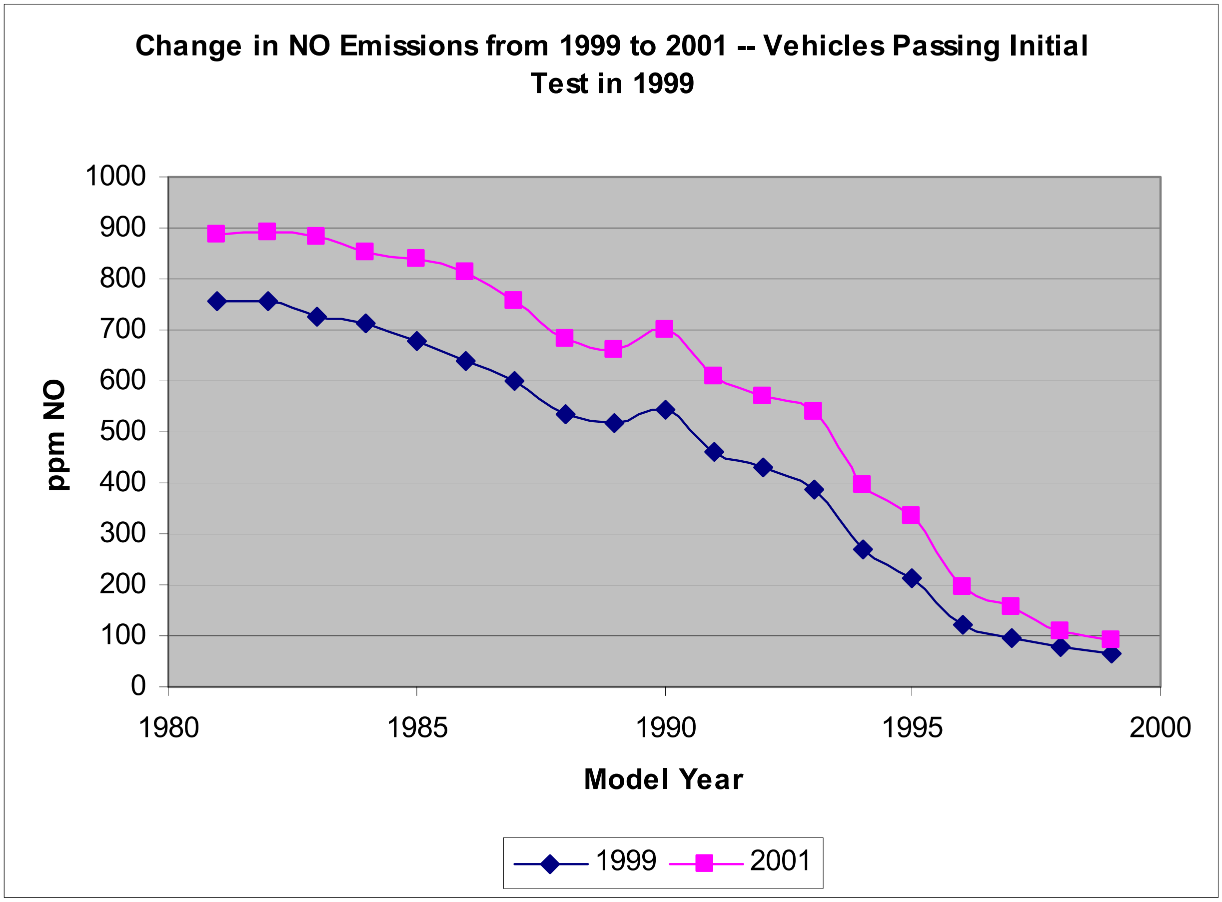
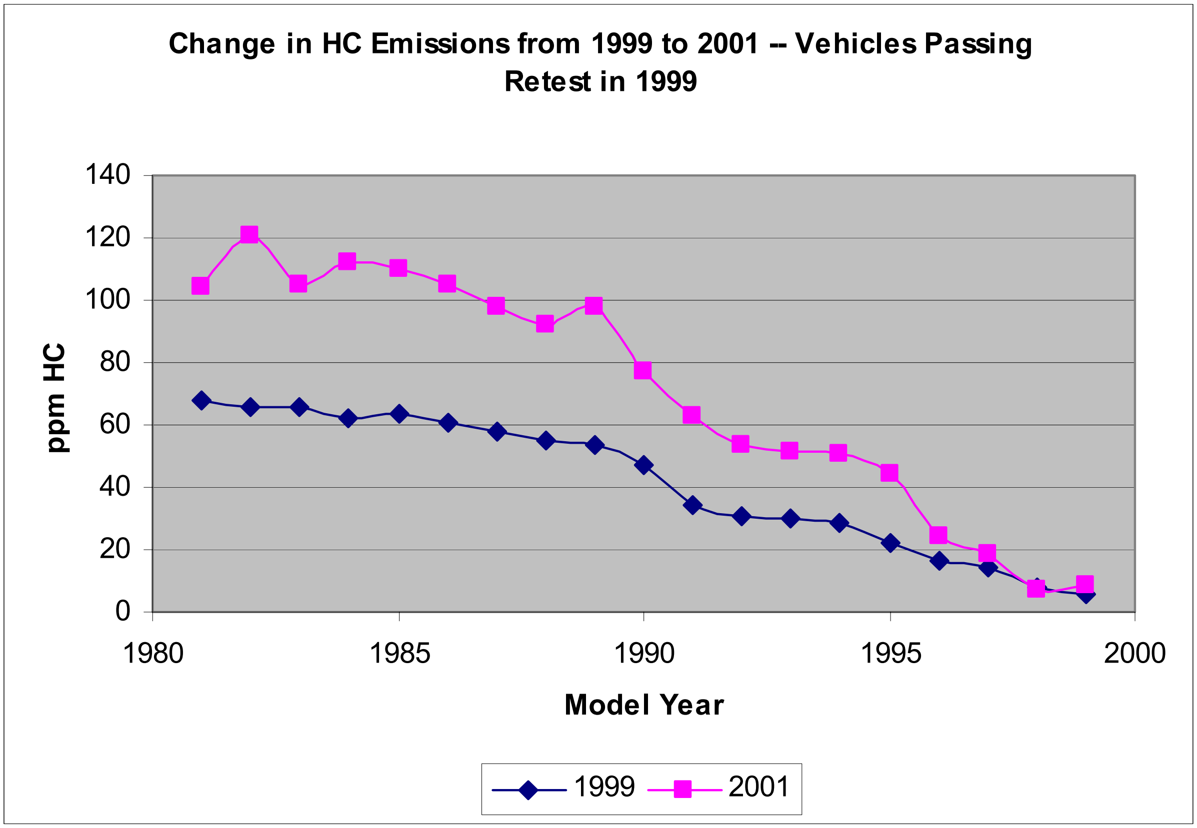
LDGT(1&2) = Light-duty gasoline powered trucks



This chart shows average HC emissions by model year in 1999 and 2001 for vehicles that passed their initial test in 1999. Emissions increase significantly from 1999 to 2001, especially for the 1995 and older models.



This chart shows average NO emissions by model year in 1999 and 2001 for vehicles that passed their initial test in 1999. Emissions increase significantly from 1999 to 2001, especially for the 1995 and older models.



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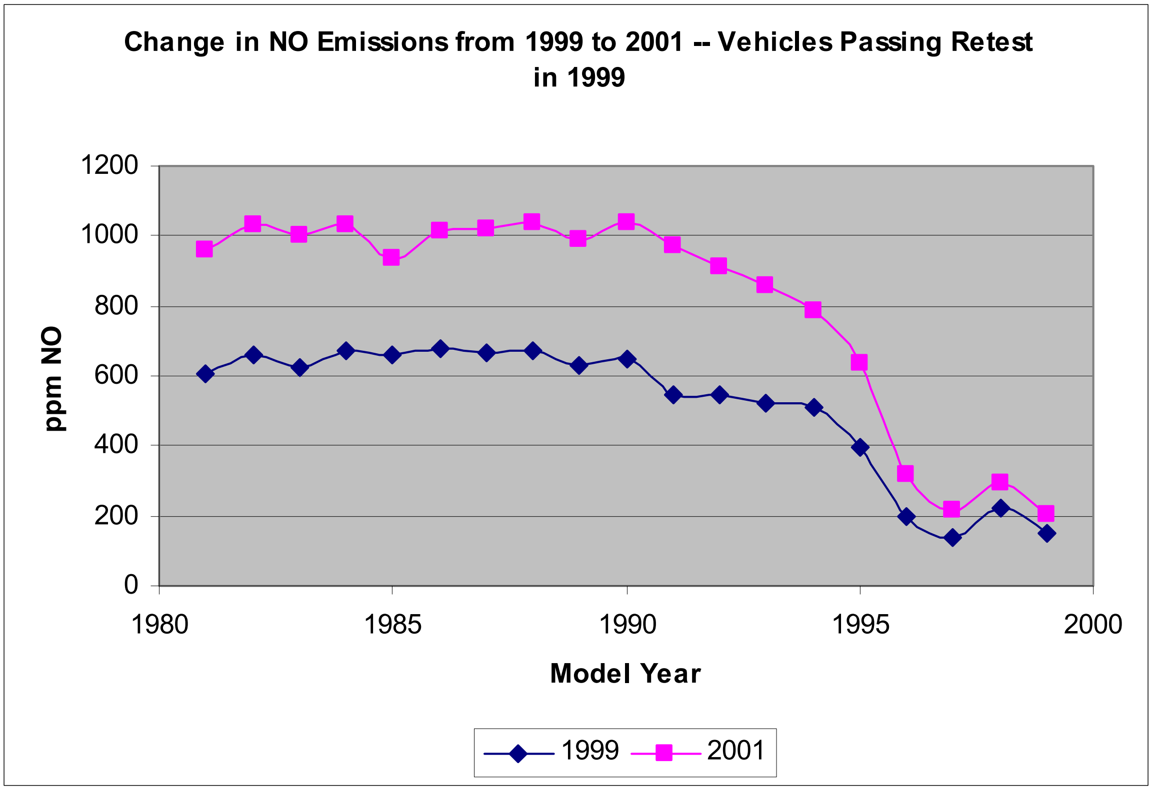

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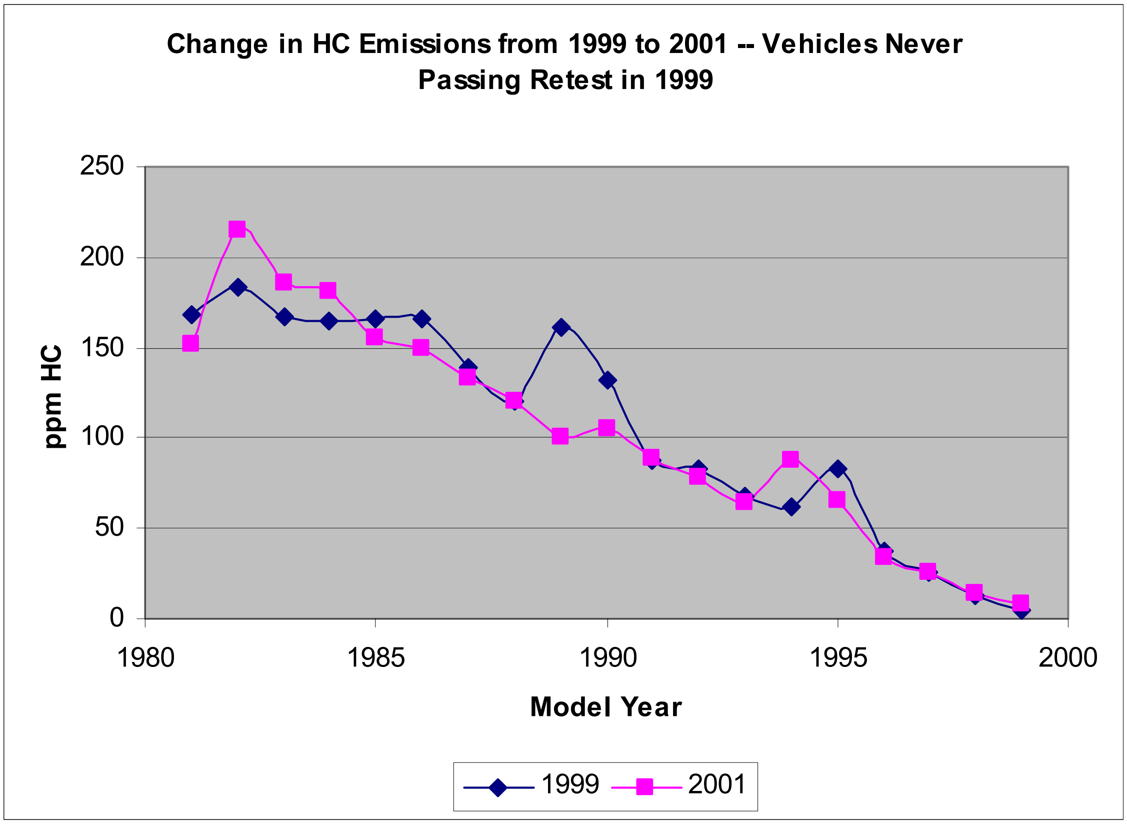
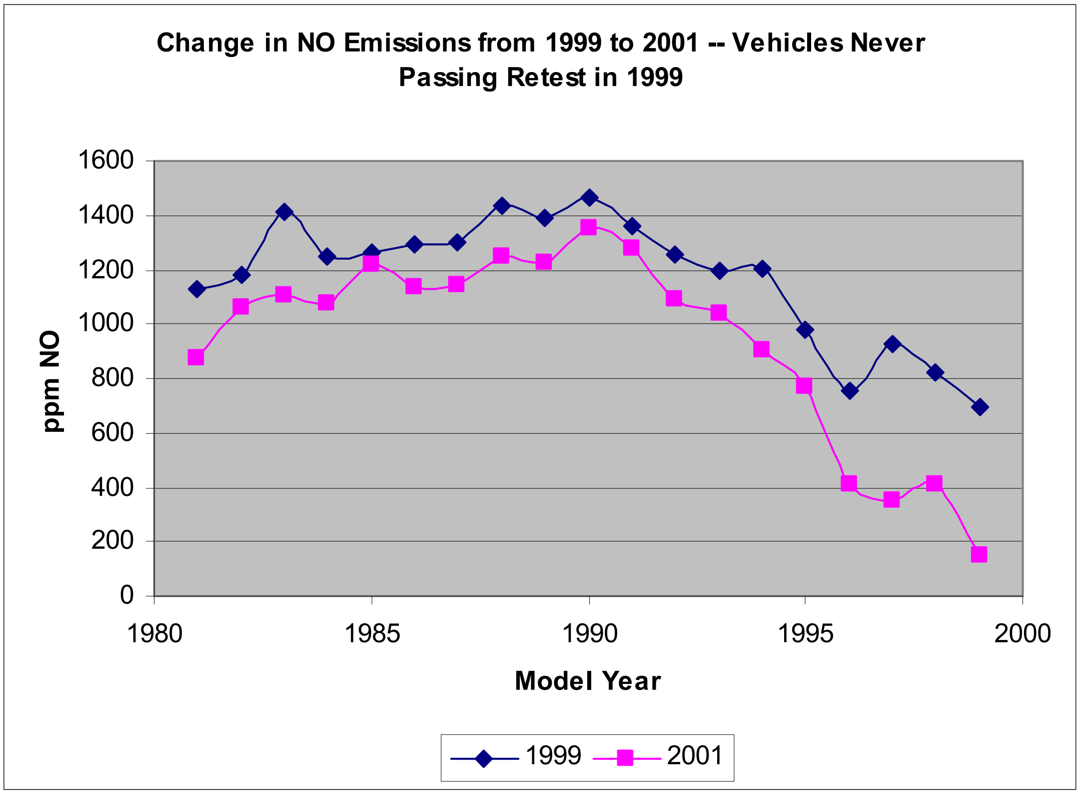


This chart shows average HC emissions by model year in 1999 and 2001 for vehicles that never passed their retest in 1999 and never received waivers. It appears that some vehicles received HC related repairs between 1999 and 2001 as indicated by the lower emissions values for some of the years. DMV's efforts to boost compliance appear to have resulted in many vehicles ultimately being repaired.



This chart shows average NO emissions by model year in 1999 and 2001 for vehicles that never passed their retest in 1999 and never received waivers. It appears that many vehicles received NO related repairs between 1999 and 2001 as indicated by the lower emissions values for all of the years. DMV's efforts to boost compliance appear to have resulted in many vehicles ultimately being repaired.

6.0 Analysis of Remote Sensing Data

- With Remote Sensing Devices (RSD), vehicle emissions are measured remotely by passing a light source across a highway to a source detector. The source detector measures absolute concentrations of hydrocarbons (HC), carbon monoxide (CO), nitrogen oxide (NO), and carbon dioxide (CO_2) in the diluted exhaust. From these measurements, exhaust concentrations of HC, CO, and NO in the undiluted exhaust are calculated.

- RSD offers the opportunity to obtain vehicle emissions measurements in a relatively non-intrusive manner. Connecticut's previous I/M contractor, Envirotest, was required to conduct on-road emission tests using remote sensing devices (RSD), in order to meet EPA's on-road test requirements.

- In 2001, Envirotest conducted approximately 75,000 tests using RSD. After removing invalid records and matching results with the vehicle registration database, 35,526 records remained (~3% of the vehicles tested in the I/M program annually).

- dKC was able to match RSD results with I/M results from 2001. We generated two datasets:

    - RSD results before I/M: 9,217 valid observations
    - RSD results after I/M: 5,903 valid observations

Observed Remote Sensing Device (RSD) Emission Levels

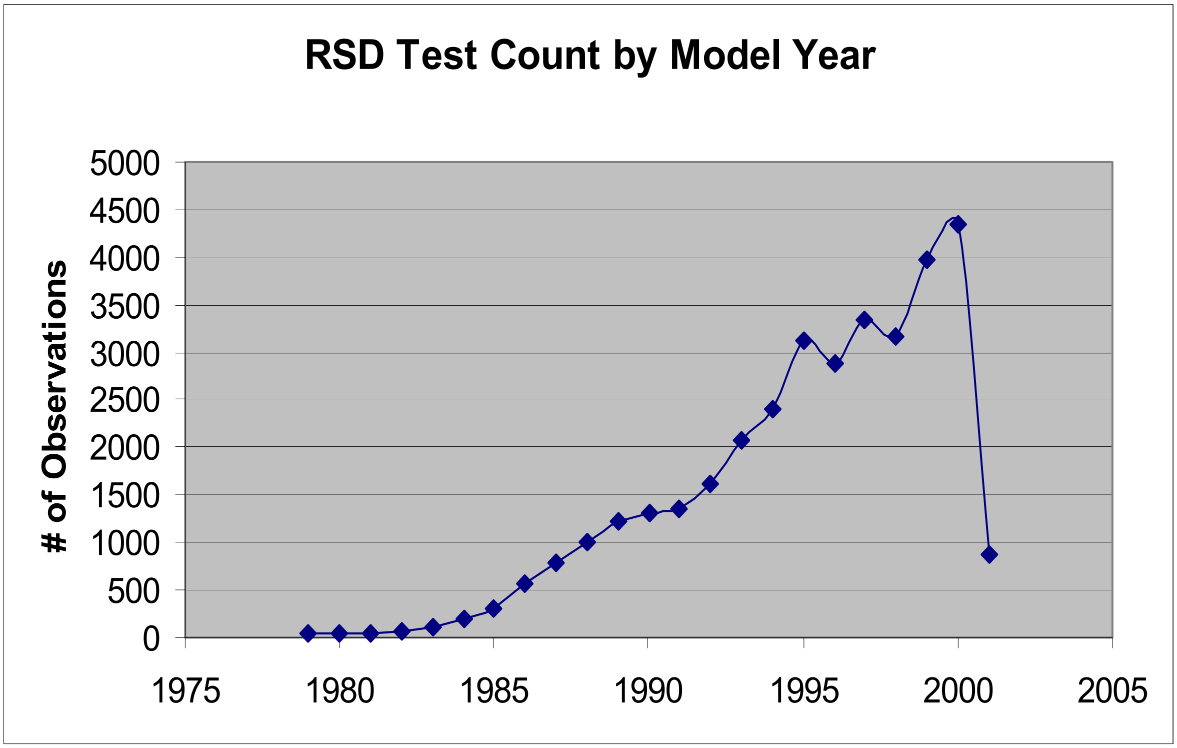
- As expected, average RSD emissions and the percentages of high emitters are lowest for the newest vehicles.

- 0.33% of the vehicles scanned exceeded the 6% RSD CO limit, which is Connecticut's criteria for identifying high emitting vehicles. In 1999, 0.49% of the vehicles tested exceeded the 6% RSD CO limit.

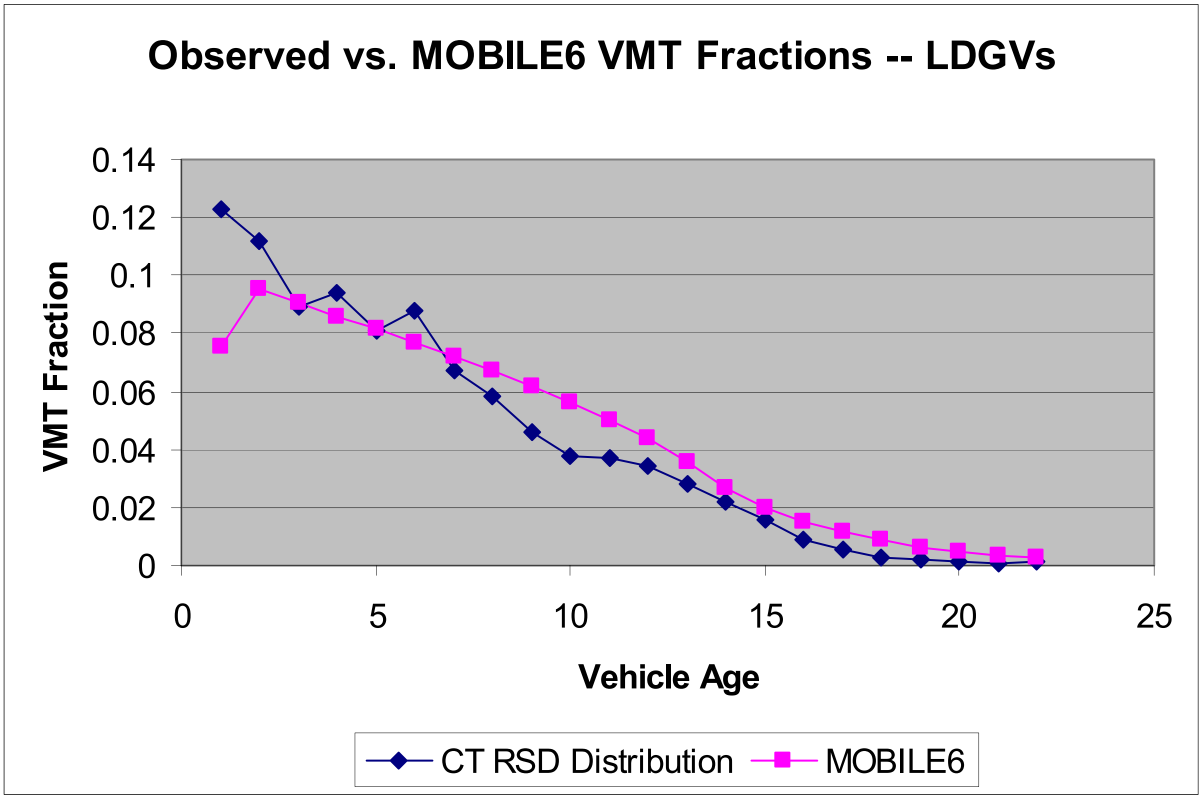
- Emission trends can be observed before and after the emissions inspection. Of particular interest are RSD emissions for vehicles that were scanned via RSD prior to failing I/M tests or after failing.

- Average RSD emission levels for vehicles that failed subsequent I/M tests were greater than average RSD emission levels for vehicles that had passed their I/M test.

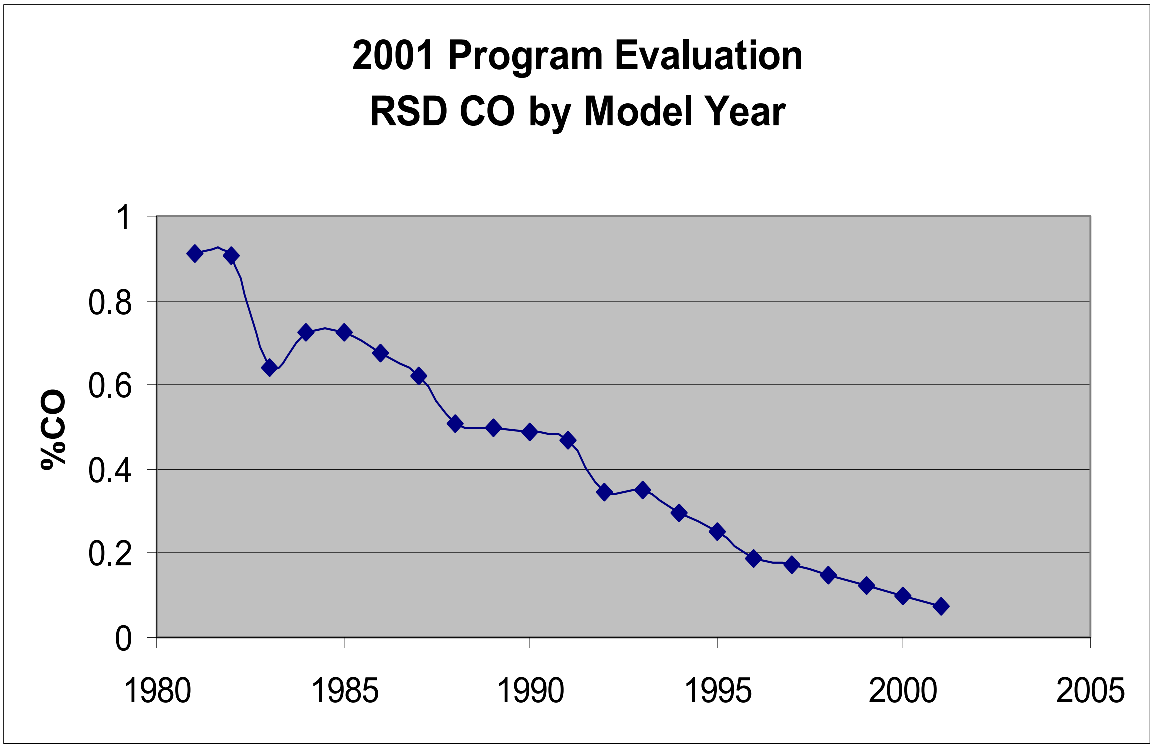
- RSD results correlate well with ASM results, indicating that tests from RSD can be used to characterize ASM emission rates. This will be important in future evaluations of Connecticut's decentralized I/M program. In these evaluations, RSD could be used to estimate how much emissions are reduced by the new program.



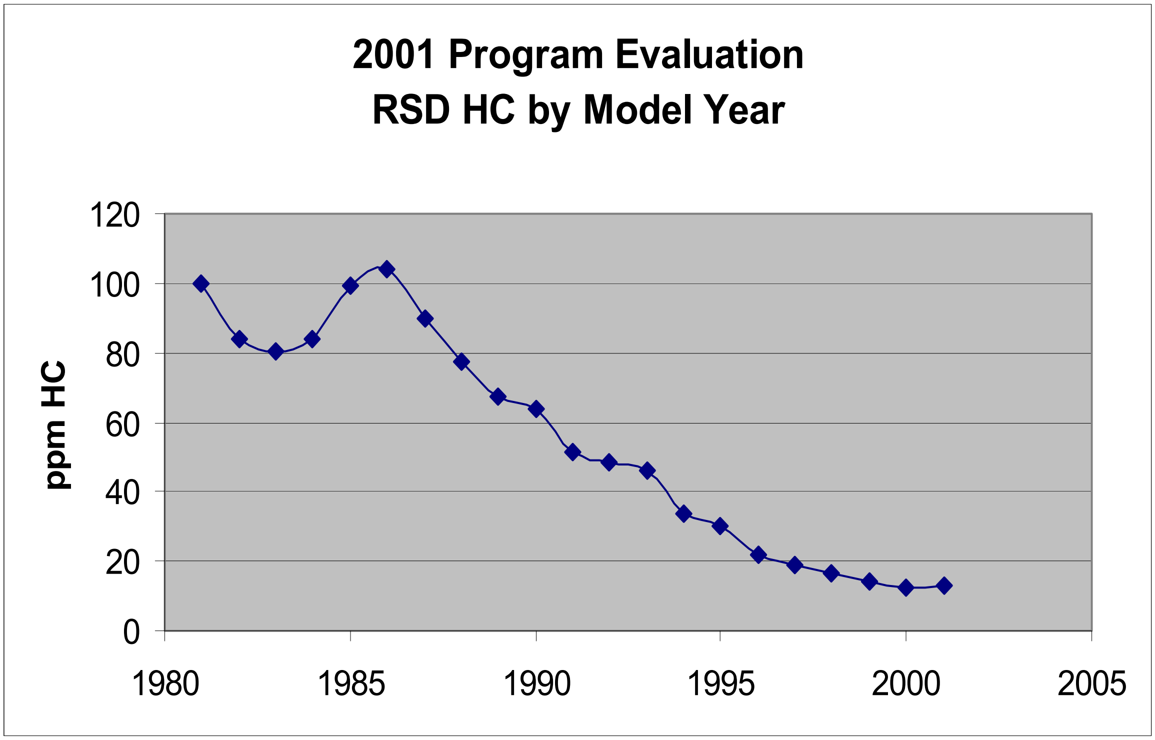
This chart shows the number of vehicles scanned by RSD by model year.



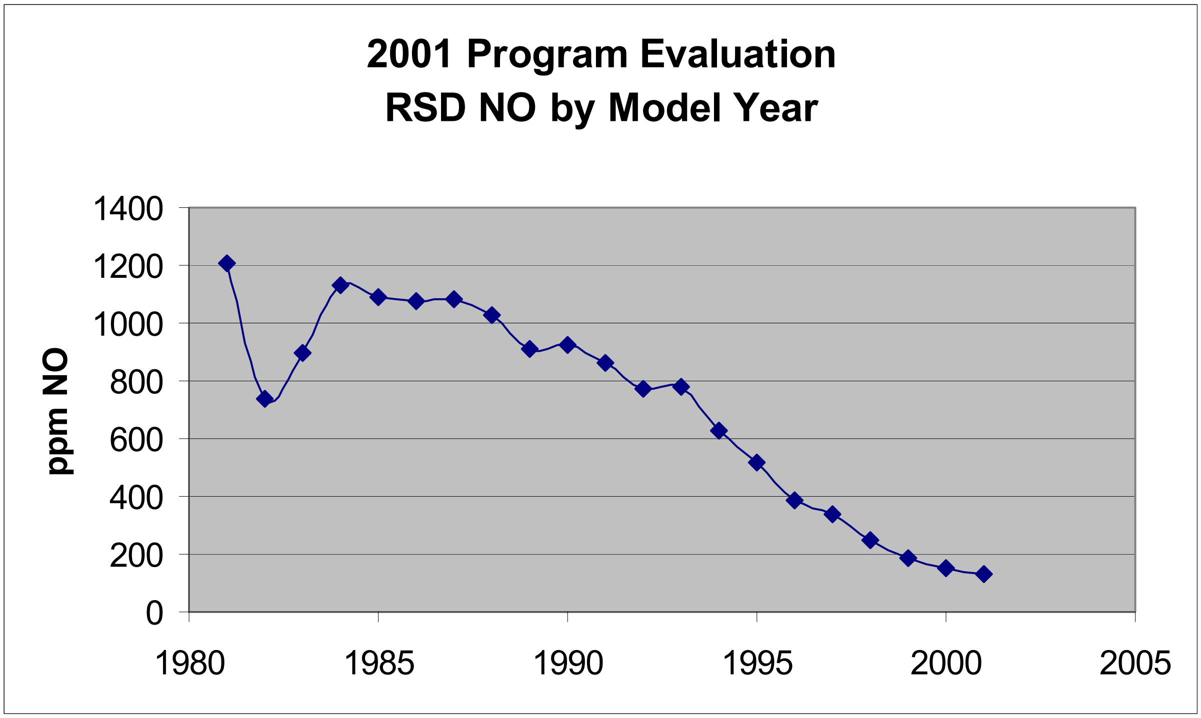
RSD observations provide a means to determine the actual on-road travel fraction. This chart shows the distribution of Connecticut vehicles scanned by RSD compared to the default travel fraction in MOBILE6. The MOBILE6 default distribution is based on national averages. Connecticut appears to have a greater percentage of new vehicles than the national average.



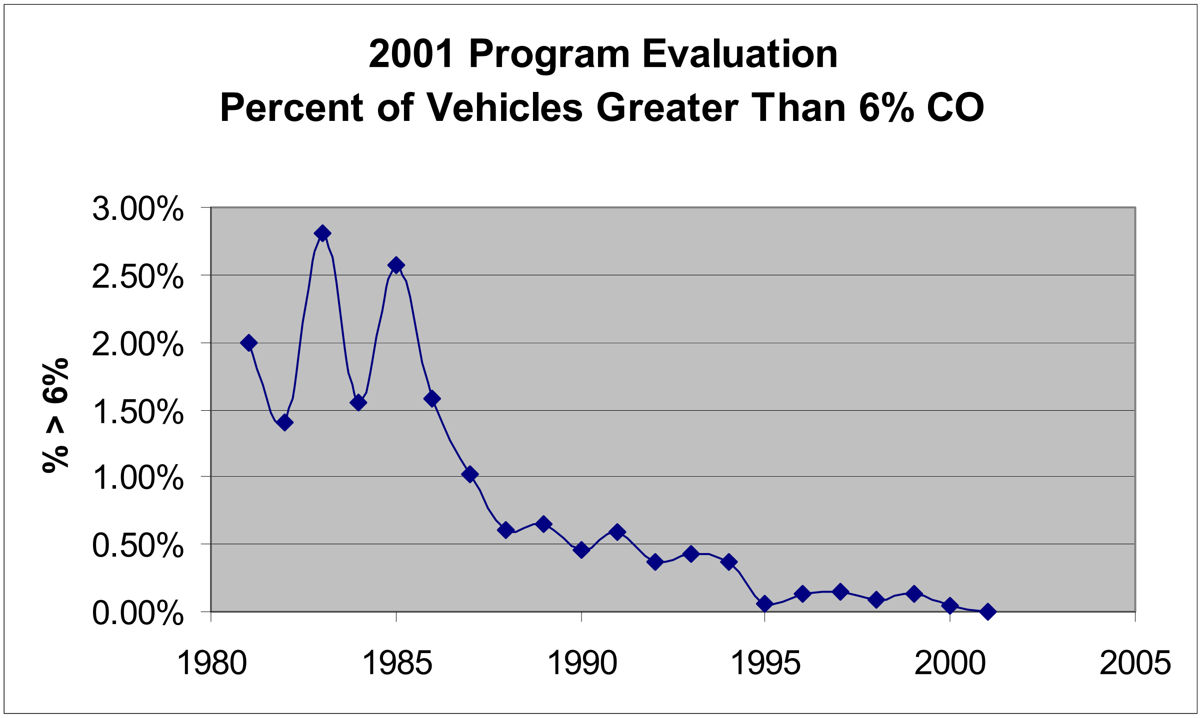
This figure shows average carbon monoxide (CO) RSD readings by model year. Generally, older vehicles have higher emission levels. The low sample sizes for the older vehicles (see chart on page 35) causes considerable variation in average readings.



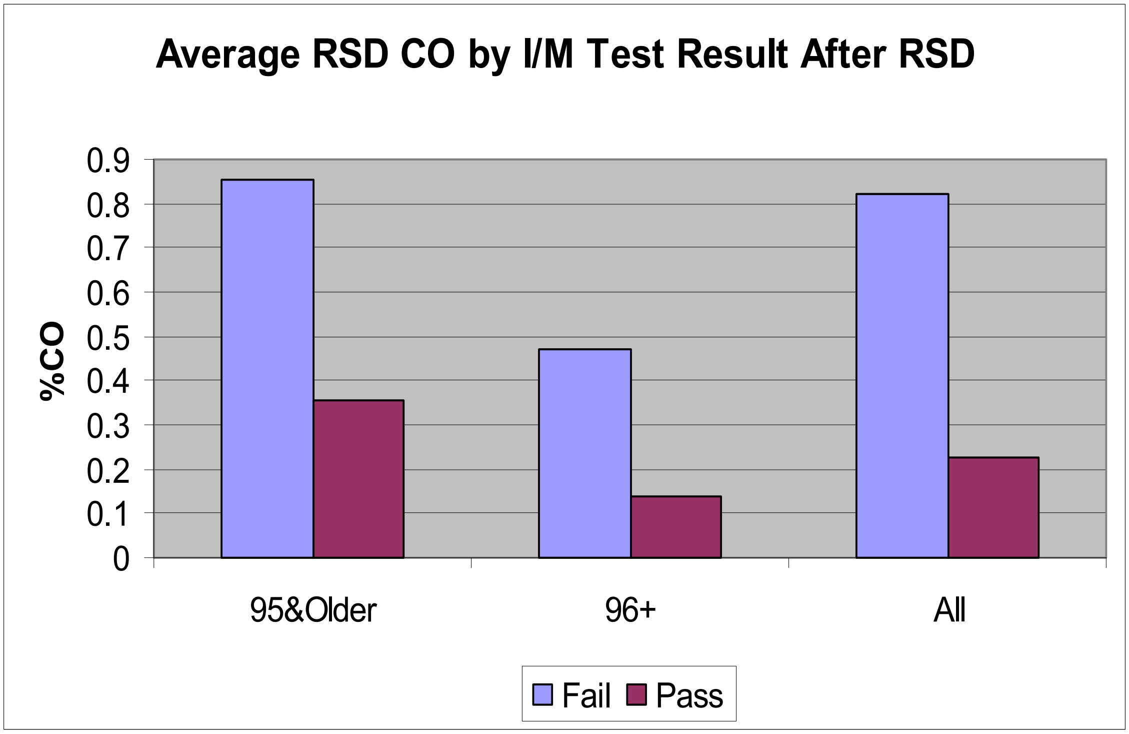
This figure shows average hydrocarbon (HC) RSD readings by model year. Generally, older vehicles have higher emission levels. The low sample sizes for the older vehicles causes considerable variation in average readings.



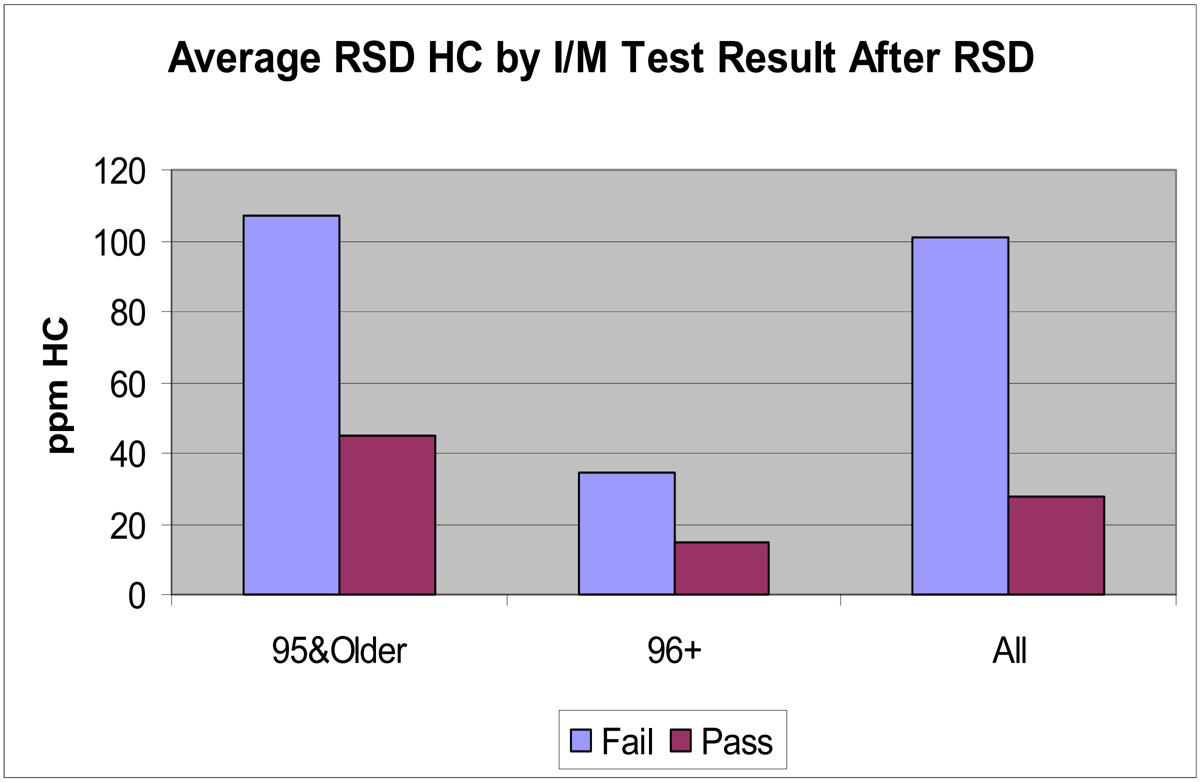
This figure shows average RSD readings for nitrogen oxide (NO) by model year. Generally, older vehicles have higher emission levels. The low sample sizes for the older vehicles causes considerable variation in average readings.



This figure shows the percent of vehicles exceeding 6% CO by model year. The greatest percentages of vehicles are between the 1981 and 1985 model years.



This figure shows average RSD CO emissions for vehicles that received an I/M test after they were observed by RSD. Results are broken down by model year and I/M pass/fail status. RSD emission levels for vehicles that failed the subsequent I/M test were much higher than emission levels for vehicles that passed. This indicates that the I/M program identifies vehicles with high emissions.



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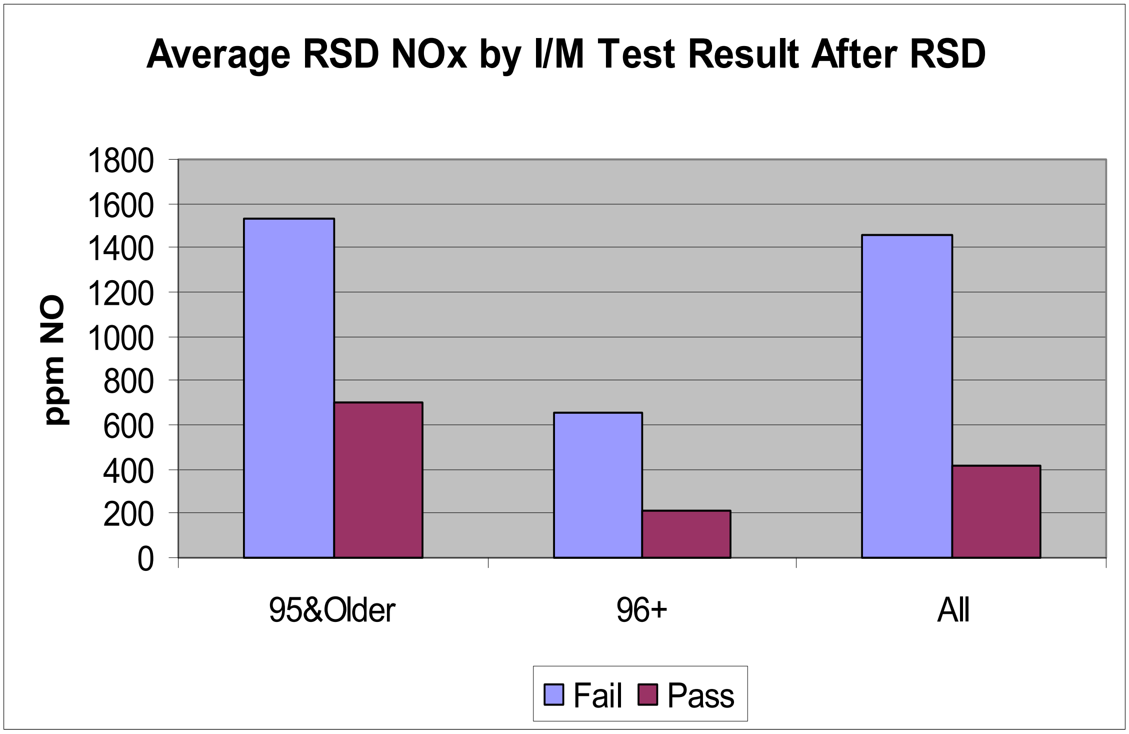
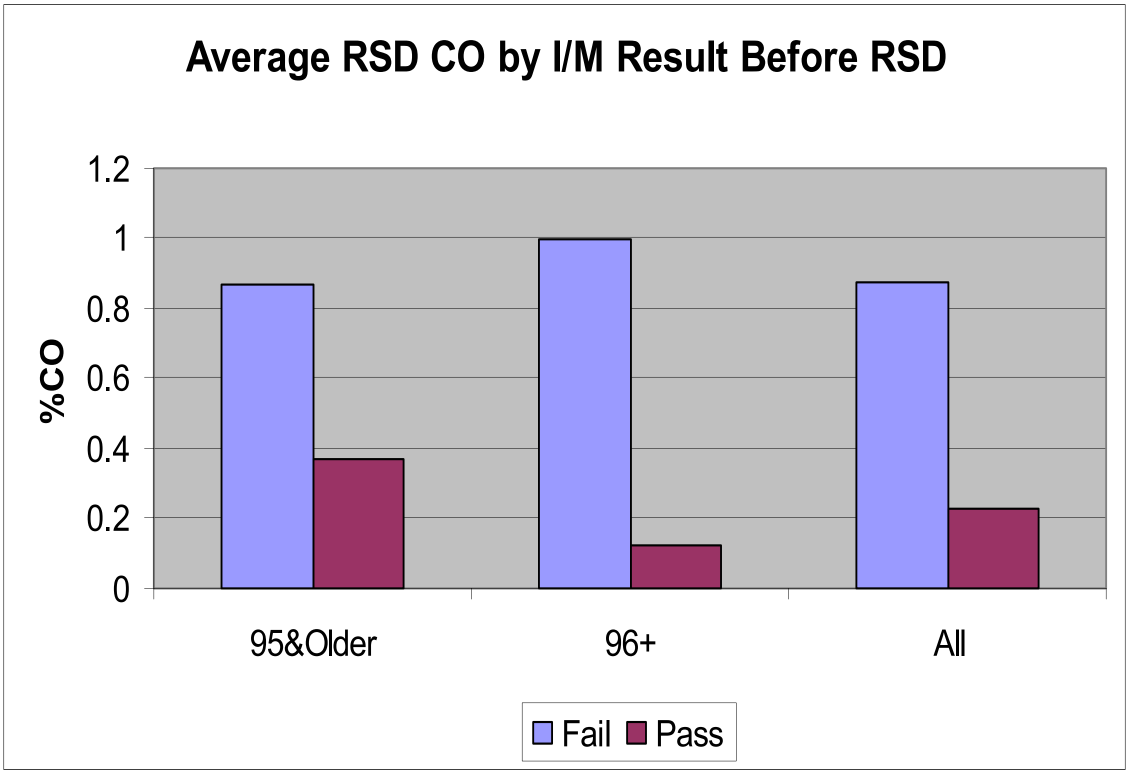
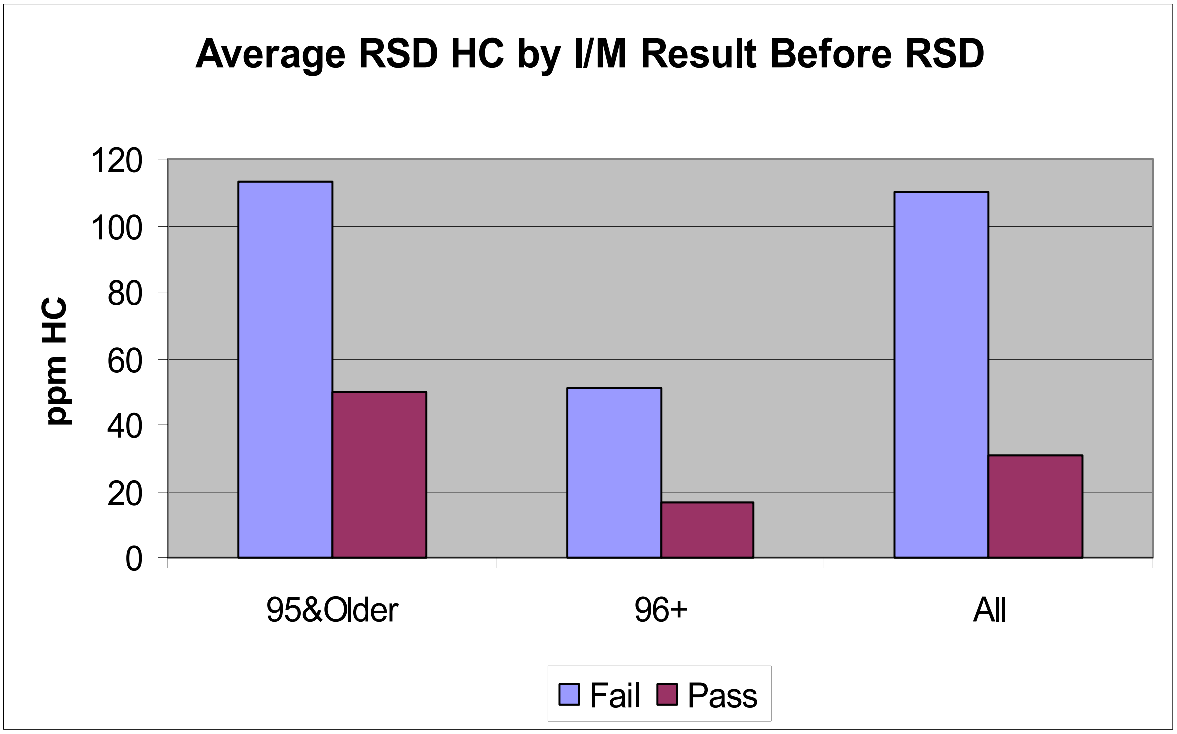


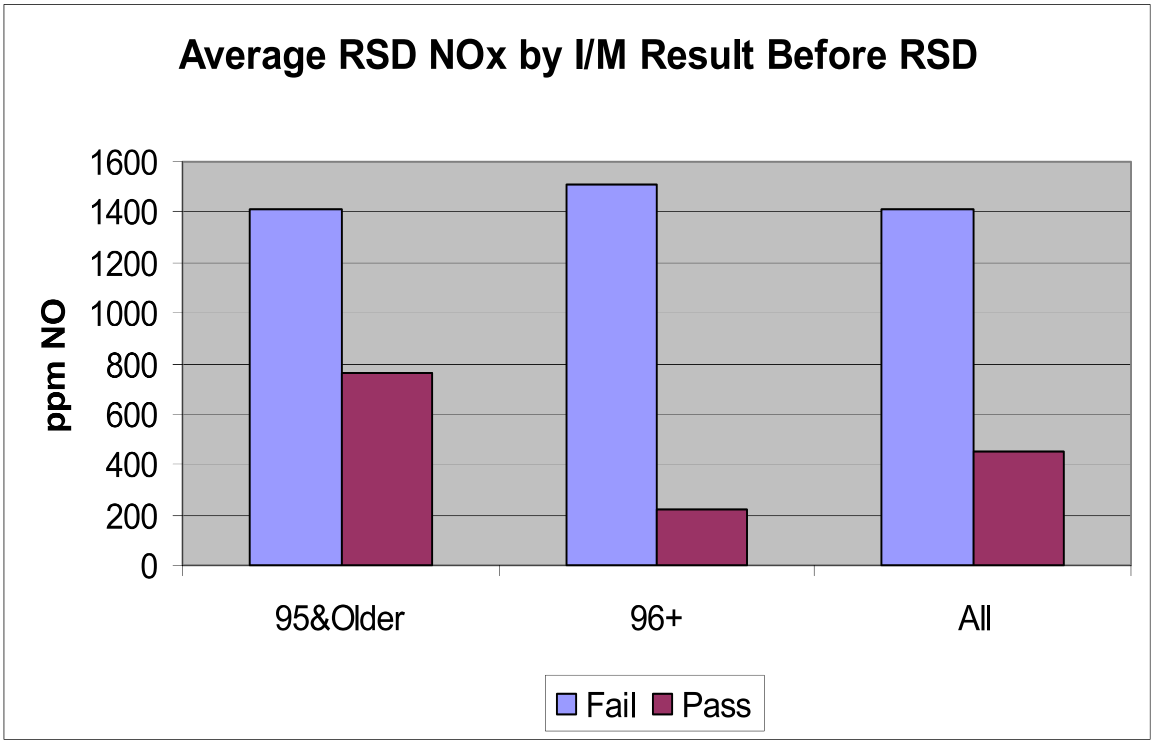
This figure shows average RSD NOx emissions for vehicles that received an I/M test after they were observed by RSD. Results are broken down by model year and I/M pass/fail status. RSD emission levels for vehicles that failed their subsequent I/M test were much higher than RSD emission levels for vehicles that passed their I/M test. This indicates that the I/M program identifies vehicles with high emissions.



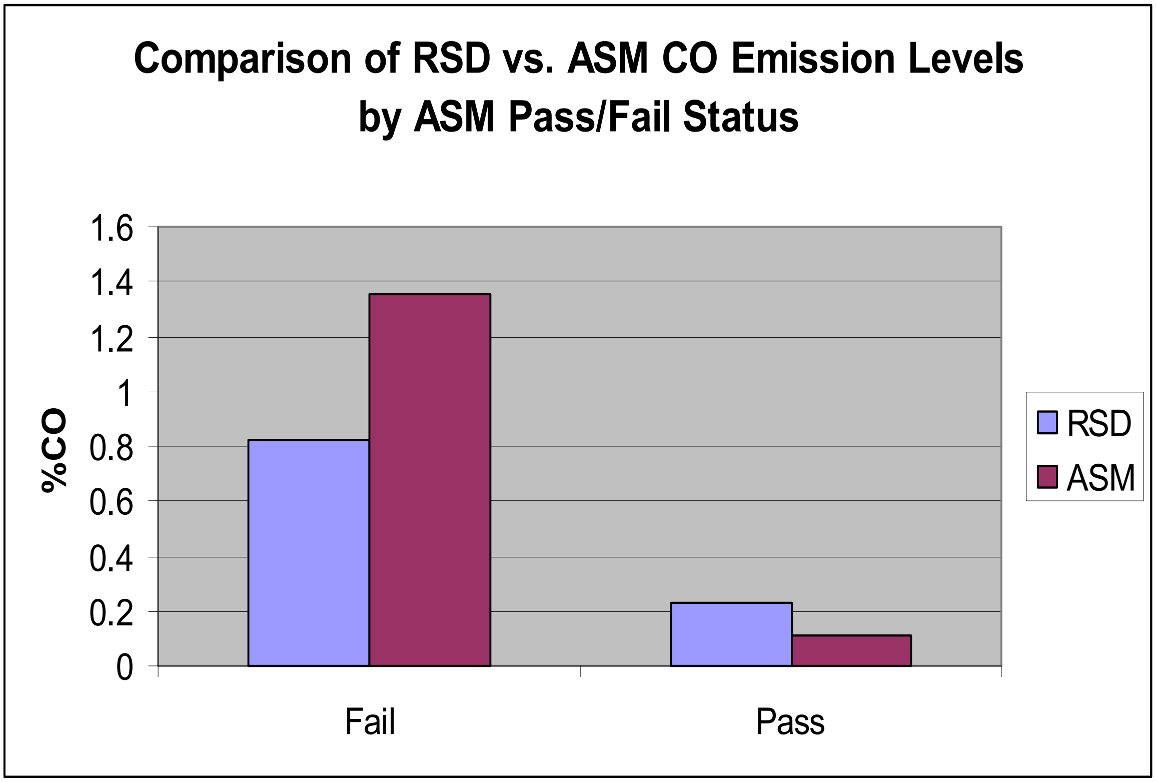
This figure shows average RSD CO emissions for vehicles that received an I/M test before they were observed by RSD. Results are broken down by model year and I/M pass/fail status of the last test before the RSD observation. RSD emission levels for vehicles that failed their subsequent I/M test were much higher than RSD emission levels for vehicles that passed their I/M test. This indicates that the I/M program identifies vehicles with high emissions.



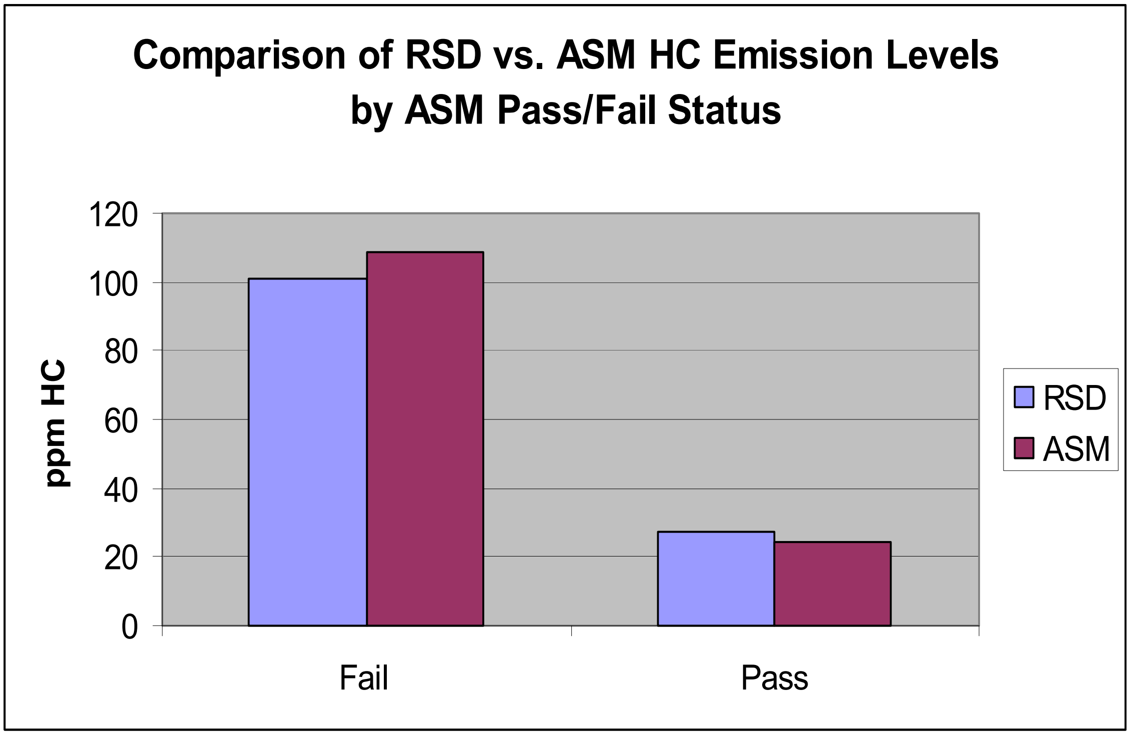
This figure shows average RSD HC emissions for vehicles that received an I/M test before they were observed by RSD. Results are broken down by model year and I/M pass/fail status of the last test before the RSD observation. RSD emission levels for vehicles that failed the previous I/M test were much higher than emission levels for vehicles that passed. This indicates that RSD can be used to identify vehicles that have yet to comply with I/M program requirements.



This figure shows average RSD NOx emissions for vehicles that received an I/M test before they were observed by RSD. Results are broken down by model year and I/M pass/fail status of the last test before the RSD observation. RSD emission levels for vehicles that failed the previous I/M test were much higher than emission levels for vehicles that passed. This indicates that RSD can be used to identify vehicles that have yet to comply with I/M program requirements.



This figure shows average RSD and ASM CO emission rates for vehicles that received an I/M test after they were observed by RSD. RSD results correlate reasonably well with ASM results, indicating that tests from RSD can be used to characterize ASM emission rates.



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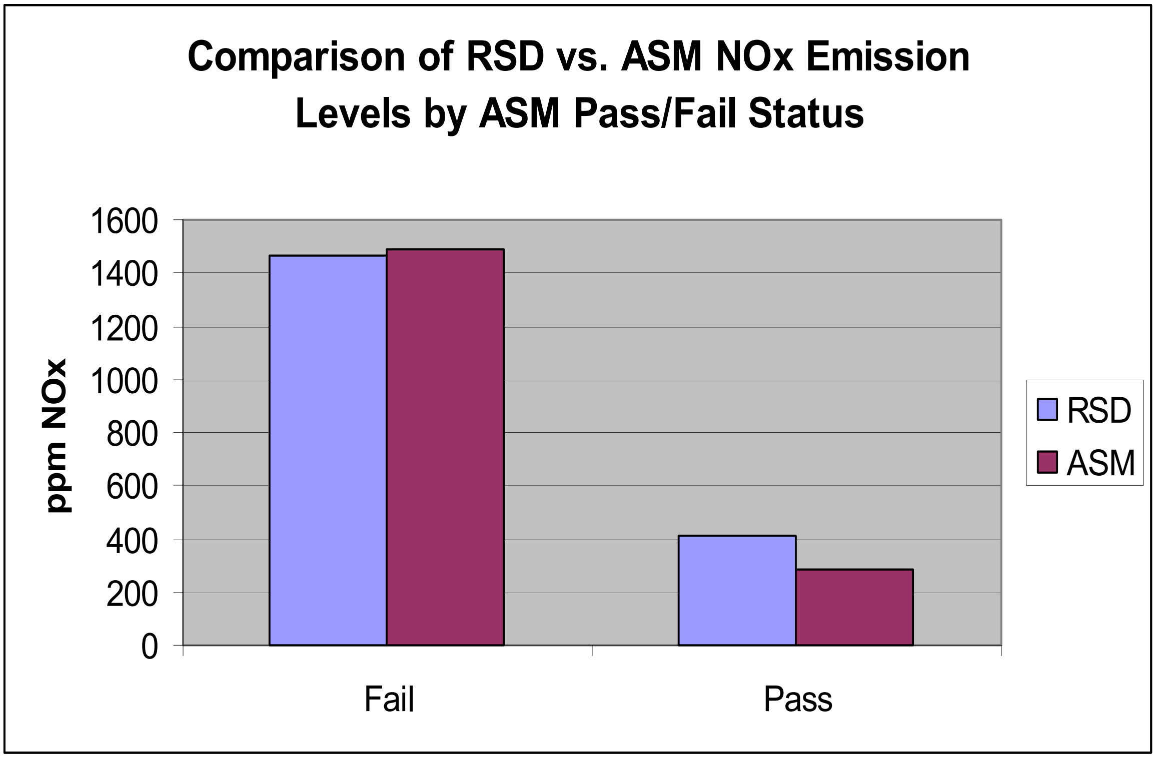

This figure shows average RSD and ASM NOx emission rates for vehicles that received an I/M test after they were observed by RSD. RSD results correlate well with ASM results, indicating that tests from RSD can be used to characterize ASM emission rates.

7.0 Audits and Other QA Activities

The new program starting in October 2003 includes extensive Quality Assurance (QA) activities by the State and its contractor (Agbar).

State Oversight

The Connecticut Department of Motor Vehicles (DMV) will perform the following oversight functions:

- Overt audits of equipment, procedures and inspectors – twice/mo. – 25 Field Agents/Contract Compliance Officers
- Covert audits of Stations/inspectors – both testing and repair – twice/year per station
- 4 Dedicated Video auditors – monitoring inspections during station operating hours
- 3 Record auditors – monitoring trigger and anomaly audits daily
- 4 QA auditors performing equipment and calibration 2 point and 5 point audits
- Remote wireless auditing/viewing of station activities (to be implemented in the future)
- Customer satisfaction surveys
- Registration denial via the EDBMS – this will eliminate the need to enforce emissions stickers

Contractor QA Activities

Fraud Prevention Systems

- Secure IRIS recognition system – use of biometrics
- Digital Web Cameras – Video Monitoring System
  - Real time monitoring/control of vehicle inspections
  - Video auditors can selectively view inspections
  - If anomalies are detected – inspection can be halted
- Trend analysis monitoring –
  - Test time duration
  - Initial & Retest pass/fail rate
  - Repair costs
  - Waivers
  - Speed variability check
  - Gas cap failure analysis
  - After hours inspection analysis
  - Aborted inspection analysis

Automated QA Functions

- Sample system leak check
- Analyzer gas calibrations – Every 72 hours or system will lock out testing
- CDAS units require a 2 point calibration with BAR 97 High gas – followed by BAR 97 Low gas blend
- CDAS units are BAR 97 certified
- Dynamometer undergo a coast down every 72 hours
- Raw transport time verification
- Various other Hardware checks are done every 72 hours
- Low sample flow, low ASM flow, Sample dilution checks etc.

Contractor QA Activities (cont.)

Inspection Results Analysis Audits – monitoring of performance indicators

- # of offline inspections
- Short period between tests
- Transient failures
- Gas Cap failures
- OBD failures
- After hours testing

Digital Audits – monitoring of equipment service and repair

- Leak check failures
- NO cell age
- Gas cap calibration failure
- NO response time
- CO response time
- O2 response time
- NO low calibration gas drift
- Bench low calibration failure rate
- Parasitic loss changes

8.0 Conclusions

Following are the key conclusions from this analysis:

- Based on data collected in Connecticut's I/M program, one inspection and repair cycle reduces ***overall*** fleet emissions by the following percentages:
    - 31.1% for CO
    - 17.4% for HC
    - 10.6% for NOx

- Based on actual test lane data, emission reductions from **failing vehicles** repaired as a result of the I/M program are calculated to be:
    - 84.2% for carbon monoxide (CO)
    - 63.2% for hydrocarbons (HC)
    - 56.1% for oxides of nitrogen (NOx)

- Overall, 27,312 vehicles that failed the test in 2001 (28.1% of the failures) did not receive a passing result (or waiver) by June 2002. This is an improvement over 1999, indicating that DMV's efforts to boost compliance have been successful.

- Connecticut's I/M test identifies vehicles that were observed to have high emissions during independent on-road (remote sensing) tests.

- Connecticut plans to conduct extensive Quality Assurance (QA) activities on the new I/M program. Also, enforcement of motorist compliance will be enhanced by making compliance with I/M standards a prerequisite to vehicle registration.