

Mass Emissions Repair Effectiveness Study

July 1998 through October 1999

December 22, 1999

**Steve Kukawka
Instructor
Gateway Technical College
1001 S. Main Street
Racine, Wisconsin
53403
(262) 619-6492**

Acknowledgments

A special “Thank You” to the following repair facilities for their participation, input, and the repair of the study vehicles.

Girards Service Center
3018 S. Chicago Ave.
South Milwaukee, WI 53172
(414) 764-2030

Patrick Automotive
4925 30th Ave.
Kenosha, WI 53144
(262) 652-8292

Nelson Carburetor and Automotive
1409 13th St.
Racine, WI 53403
(262) 633-2822

Jeff’s Automotive
5261 S. Nicholson Ave.
Cudahy, WI 53110
(414) 482-3080

An additional “Thank you” to Envirotest Wisconsin, Inc. for allowing the vehicle testing to be conducted at their Technical Assistance Centers, and special thanks to their diagnostic technicians Tom Fitzpatrick and Ken Dotzler.

Thank you to the following people for their help and input throughout the study.

Muhammed Islam - Vehicle Emission Control Engineer - Wis. DNR

Jerry Medinger -Air Management Specialist - Wis. DNR

Chuck Rhodes - Quality Assurance Unit Supervisor - Wis. DOT

Dan White - Quality Assurance and Training Manager - Envirotest Systems

Chris Bovee -Air Management Specialist - Wis. DNR

Dennis Sherwood -Dean of Trades and Transportation – Gateway Technical College

Brian Buckta - Communications Director - Braun’s R&D Services

Table of Contents

EXECUTIVE SUMMARY	4
INTRODUCTION	5
PROJECT BACKGROUND	6
METHODOLOGY	14
RESULTS	15
CONCLUSIONS	30
RECOMMENDATIONS	32
APPENDIX	33
GLOSSARY OF TERMS	66

Executive Summary

The Mass Emissions Repair Effectiveness Study was conducted to verify the hypothesis that the effectiveness of aftermarket emission repair is a determining factor in the increased level of emission test failures in southeastern Wisconsin. In applied theory, this hypothesis proposes that common ineffective aftermarket emission repair procedures are treating general symptoms, rather than effectively diagnosing and repairing the root cause of the failure. Funding for the study was obtained through a CMAQ (Congestion Mitigation and Air Quality Improvement Program) grant, which provided 80% of the repair costs of the vehicles in the study, up to a maximum of \$450 per vehicle.

Analysis of Wisconsin Vehicle Inspection Program failure data identified two engine families as having prominently high initial test and high retest failure rates:

- General Motors Oldsmobile carbureted 5.0L (307cid) VIN “Y” engine with Computer Command Control (CCC) installed in full size vehicles from 1980 through 1990
- General Motors Chevrolet carbureted 5.0L (305 cid) VIN “H” engine with Computer Command Control (CCC) installed in full size vehicles from 1981 through 1988

Currently, many of the target vehicles in those engine families are failing the initial Wisconsin I/M 240 test, failing the retest, and qualifying for emission waivers due to the cost of repairs. This practice allows these vehicles to continue emitting high levels of pollutants until the next inspection is due (currently a 2-year period). A total of 81 target vehicles participated in the study.

The study was designed to achieve the following objectives:

1. Obtain pertinent frequency data on the types of emission repairs performed
2. Evaluate the effectiveness of the WISETECH (Wisconsin Emission Technician) training program
3. Provide a basis to determine Wisconsin’s policy on future emission limits and repair waivers

The study incorporated:

- Repair facility cooperation
- Vehicle owner cooperation
- Wisconsin Vehicle Inspection Program cooperation
- Wisconsin DOT cooperation
- WISETECH training theory
- Wisconsin DNR data analysis
- EPA mobile emission cutpoint recommendations

The study results include such findings as:

- Average effective repair costs are only marginally higher than the current waiver qualification amount.
- Most of the vehicles in the study required repair in several areas.
- Vehicle preconditioning and catalyst replacement had dramatic effects on the pass/fail rate.
- The study sample emission statistics are very near representation of average total fleet emissions for the model years studied.

This report closes with a full series of conclusions from the study findings, and practical recommendations towards helping to reduce ozone air pollution from motor vehicles in southeastern Wisconsin and other nonattainment areas across the country. For your convenience, a **Glossary of Terms** is provided at the back of this booklet.

Introduction

The Enhanced Emission Inspection Program in southeastern Wisconsin was introduced in 1995. Since that time, specific ‘engine family’ vehicles have consistently reported a high volume of primary and secondary test failures. As emission cutpoints (maximum allowable emissions) in the Wisconsin Vehicle Inspection Program were gradually lowered to the EPA’s final recommendations, the failure rates for these vehicles have reflected gradual increases (see Appendix ‘A’ for in-depth information on emission cutpoints).

Many questions were raised, and many issues were discussed as possible causes and solutions for these phenomena. A hypothesis for the study resulted from these discussions: Failure rate changes are directly related to repair effectiveness. In applied theory, this hypothesis proposes that common ineffective aftermarket emission repair procedures are treating general symptoms, rather than effectively diagnosing and repairing the root cause of the failure. To verify this hypothesis, the Wisconsin Department of Natural Resources (DNR) Bureau of Air Management contracted Gateway Technical College to conduct an aftermarket emissions repair effectiveness study on a select sample of specific ‘engine family’ vehicles. Repairs to the target vehicles were performed by automotive repair facilities employing WISETECH (Wisconsin Emission Technician) training program graduates. To provide incentive for vehicle owner participation, the contract (through a CMAQ grant) committed to pay for 80% of vehicle emission repair costs, up to a maximum of \$450 (current waiver amount) per vehicle for parts and labor. The study was designed to achieve the following primary objectives:

1. Obtain pertinent emission repair frequency data

This information can be used to develop a hierarchy of effective emission repairs for the working automotive technician. The informed technician will have a greater opportunity to offer cost-effective emissions diagnosis and repair to the motorist.

2. Evaluate the effectiveness of the WISETECH training program

Is the WISETECH program effective in preparing technicians to diagnose and repair failed vehicles?

3. Provide a basis to determine Wisconsin’s policy on future emission limits and repair waivers

Are these engine families able to meet tighter emission cutpoints? Would a higher waiver requirement cause more of these vehicles to comply with cutpoints? Would preconditioning these vehicles help them to pass inspection?

Project Background

The ultimate goal of this project is to help reduce ozone air pollution from motor vehicles in U.S. cities that have been designated as Ozone Nonattainment Areas by the EPA (Environmental Protection Agency). EPA studies indicate that the 2 primary sources of air pollution in these areas are:

1. Industry – The EPA estimates that industry produces nearly 40% of all ozone air pollution in U.S. cities. The EPA estimates the cost for significantly reducing pollutants in industry is approximately 10 times the cost to create a similar reduction in motor vehicle emissions.
2. Motor Vehicles - The EPA estimates cars and light trucks produce nearly 50% of all ozone air pollution in U.S. cities. These vehicles emit large quantities of:
 - Hydrocarbons (HC) - HC is unburned fuel that enters the atmosphere from either the vehicles' exhaust or by evaporation.
 - Carbon monoxide (CO) - CO is an indicator of a rich air fuel mixture during combustion.
 - Oxides of nitrogen (NO_x) - NO_x is a by-product of the combustion process. A certain amount is always present in the exhaust, but high levels can be controlled.
 - Carbon dioxide (CO₂) - CO₂ is a normal, relatively harmless by-product of combustion. (HC and NO_x are the primary components in the atmospheric photochemical process that form ground-level ozone. Ground level ozone is the principle ingredient in smog.)

To reduce auto emissions, the EPA enacted a 3-point plan for the automotive industry:

1. Development of cleaner vehicles
2. Development of cleaner fuels
3. More effective emission inspections for in use vehicles (This creates a dramatic impact on the vehicle owners and the automotive repair industry. See Figure 1 for details)

Impacts of Emission Testing

Vehicle Owner	Repair Industry
<ul style="list-style-type: none"> • The vehicle owner must have their vehicle inspected for compliance. • If the vehicle fails the emission test, the vehicle must be repaired and reinspected before the registration is renewed. • This process may seem inconvenient and time consuming for the owner. • A benefit to the owner is fuel savings. Vehicles with lower emission levels are, for the most part better running cars, which use less fuel that could provide cost savings at the gas pump. • In addition, the vehicle owner breathes cleaner air which also provides health benefits. 	<ul style="list-style-type: none"> • The repair industry may need to purchase specialized equipment to properly perform emission repairs. • A highly skilled service technician is needed to perform emission diagnostics so up to date specialized training is needed. • Businesses that effectively repair failed vehicles will see more business, customers, and profits.

Figure – 1

Project Background (Cont.)

Under the Clean Air Act, southeastern Wisconsin is designated as a severe Ozone Nonattainment Area. As an integral component in the 3-point plan for reducing auto emissions, a vehicle emission inspection program is mandated for the area. The simple idle emissions test of the Wisconsin Vehicle Inspection Program (WVIP) was started in 1984 (Figure 2 charts the history of the WVIP). The idle test was fairly accurate at identifying pre-computerized engine control vehicles that emitted unacceptable exhaust levels. As computerized automotive technology was introduced, the idle test became outdated.

Wisconsin Vehicle Inspection Program Time Line

1972	Clean Air Act of 1970 (testing optional)
1977	Clean Air Act Amendments of 1977 (testing mandated)
1984	Idle Test Emission Inspection starts. All vehicles preconditioned on dynamometer Waiver amount \$55.00
1986	New lower emission limitations
1989	Fast pass idle test (no preconditioning unless needed) Emission equipment inspection <ol style="list-style-type: none"> 1. Gas Cap 2. Fuel inlet restrictor 3. Presence of a catalytic converter
1990	Clean Air Act Amendments of 1990 (enhanced testing mandated)
1993	Underhood emission component inspection Emission inspection with change of ownership Waiver cost limit increased to \$200.00 for model years 1981 and newer and \$75.00 for model years 1980 and older.
1994	Waiver cost limit increased to \$450.00
1995	Enhanced Emission Inspection (IM240) starts
1996	New lower cutpoints
1997	New lower cutpoints
1998	New lower cutpoints

Figure - 2

The Clean Air Act Amendments of 1990 required Severe Ozone Nonattainment Areas to adopt more accurate, enhanced emission test procedures. In response to EPA requirements, southeastern Wisconsin adopted an enhanced emission test procedure called I/M 240. I/M 240 simulates the actual vehicle driving on the road by using a chassis dynamometer. This is similar to the system used to certify new vehicles under the Federal Test Procedure (FTP).

Project Background (Cont.)

In the beginning, vehicle owners were slow to accept the differences between the idle emission test procedure and the I/M 240 test procedure. Although the I/M 240 test provides much better results for monitoring emissions (please see figure 3), the previous idle test was much quicker, easier, and more convenient from the vehicle owners' point of view. (Figure 4 outlines the Wisconsin I/M 240 Emissions Test procedure.)

IM 240 / Idle Emission Test Comparison

IM240 Emission Test	Idle Emission Test
Pro	Con
More accurate Emission Measurement	Poor Emission measurement
Effective NOx Measurement	Poor NOx Measurement
Simulates vehicle emission output while driving	Simulates emissions while idling
Total exhaust measured	Partial exhaust measured
Vehicle tested every 2 years	Vehicle tested every year
Tampered vehicle will not pass	Tampered vehicle may pass
Con	Pro
High cost and maintenance of equipment in testing lanes	Less equipment needed equals lower cost
More time needed to conduct the testing (longer wait times)	Less time needed to conduct the testing (shorter wait times)
Difficult for repair industry to replicate the test	Easy for repair industry to duplicate test

Figure - 3

Project Background (Cont.)

IM 240 Vehicle Testing Procedure

Step	Action
1	Vehicle owner drives to testing station.
2	Owner is greeted by lane inspector and asked for renewal postcard or VIR if the vehicle is returning after repair.
3	Lane inspector obtains vehicle's mileage and the owner is asked to shut the engine off.
4	Vehicle owner is asked to step into the waiting booth.
5	Position 1 of 3 - Data Entry Lane inspector enters vehicle information into the computer.
6	Position 2 of 3 - Vehicle is driven onto Dynamometer.
7	Vehicle is prepared for testing. Automatic wheel restraints Non drive wheels are chocked CVS hose is placed on vehicles tailpipe Cooling fan is positioned in front of vehicle
8	IM 240 test is conducted.
9	Position 3 of 3 - Gas cap pressure test.
10	VIR is printed and the test results are explained to the vehicle owner.
11	Vehicle owner returns to their vehicle.
12	If the vehicle passed, owner pays registration renewal fee. If the vehicle fails, owner must have vehicle repaired before returning for a retest.

Figure - 4

A vehicle owner may apply for a waiver for vehicles that continue to fail the emission test. A waiver may be issued when the following conditions are met:

1. The vehicle has failed an emission test and following repair and retest, it still does not pass the emission test.
2. Emission related repairs must have been performed at a recognized repair facility for model years 1981 and newer.
3. The actual repair cost of emission related repairs must exceed the limit of \$450.00.
4. A completed Vehicle Inspection Report is presented to the Waiver Inspector.
5. The vehicle must pass a waiver emission equipment inspection.

The waiver allows registration renewal until the next required emission test.

Project Background (Cont.)

The transition from the idle emission test to the I/M 240 test also created a tremendous demand for technician training. Emission repair techniques and procedures that were effective for the old technology became largely ineffective with the new technology. In response to this demand, the State of Wisconsin adopted a training curriculum to provide new technology training to the repair community. In 1995, the State of Wisconsin introduced the WISETECH (Wisconsin Emission Technician) training program. WISETECH was developed as a voluntary, CMAQ subsidized training program offered to the automotive repair community by technical colleges in southeastern Wisconsin. Although the initial CMAQ funding has expired, WISETECH continues to offer low cost, state-of-the-art instruction on enhanced emission inspection (IM240) diagnosis and repair to automotive technicians in southeastern Wisconsin.

Target Vehicle Selection

Analysis of Wisconsin Vehicle Inspection Program failure data for Light Duty Gas Vehicles (LDGV) identified General Motors as the manufacturer of a majority of failing vehicles (Figure 5 and Figure 6). This is due to the heavy distribution of General Motors vehicles in the fleet, as compared to other manufacturers. Further analysis of WVIP failure data identified two engine families as having prominently high initial test and high retest failure rates (Figure 7 and Figure 8). The first is the General Motors Oldsmobile carbureted 5.0L (307 cid) VIN “Y” engine with Computer Command Control (CCC) installed in full size vehicles from **1980 through 1990**. The second engine family is the General Motors Chevrolet carbureted 5.0L (305 cid) VIN “H” engine with Computer Command Control (CCC) installed in full size vehicles from **1981 through 1988**. Both engine families were factory-equipped with consistent fuel systems and computer system technology throughout the model year ranges specified above. The Wisconsin Emissions Program Technician Training Subcommittee reviewed and verified all of the selection data. A total of 81 target vehicles participated in the study:

- 64 VIN “Y” vehicles
- 17 VIN “H” vehicles

Repair Facility Selection

The initial selection of prospective repair facilities was determined by the following criteria:

- The prospective facility must employ a WISETECH graduate.
- The prospective facility’s Repair Effectiveness must be over 90% as published in the October 1997 through March 1998 Emission Repair Facility Report (Blue Book).
- Prospective facility’s repair reports must show consistent numbers of target vehicle repairs from January 1998 to April 1998. These figures indicated a high probability of additional target vehicle repairs necessary for this study.

Percentage of Total Failures by Model Year

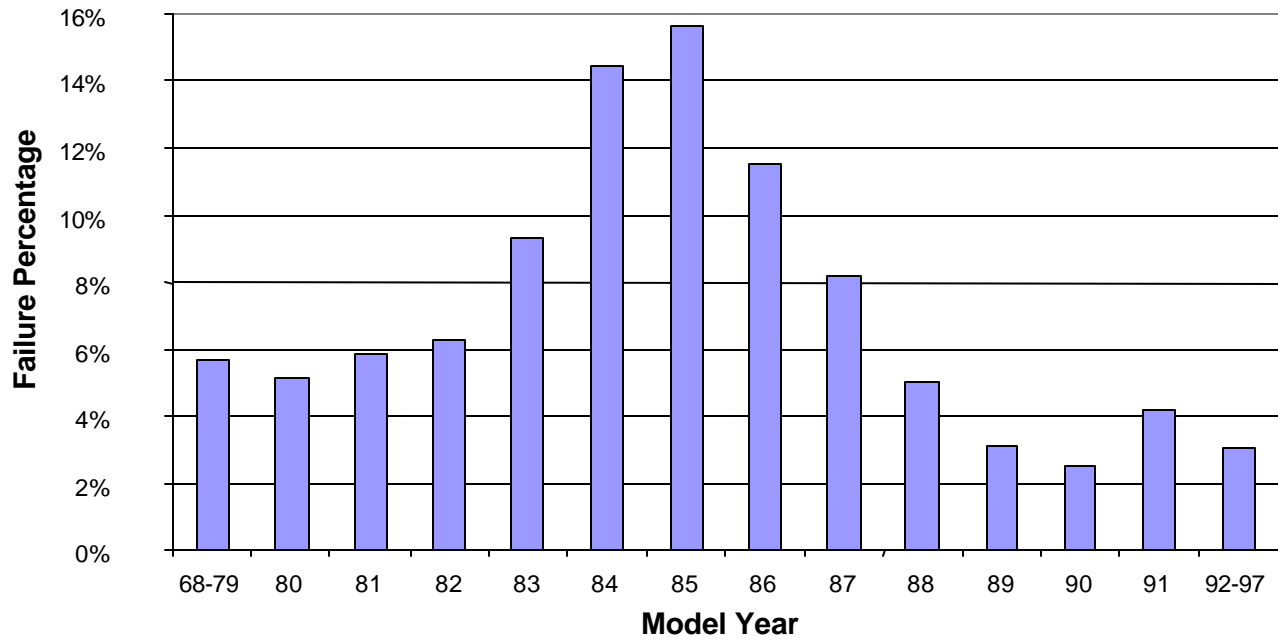


Figure 5

Percentage of Model Year Failures by Manufacturer

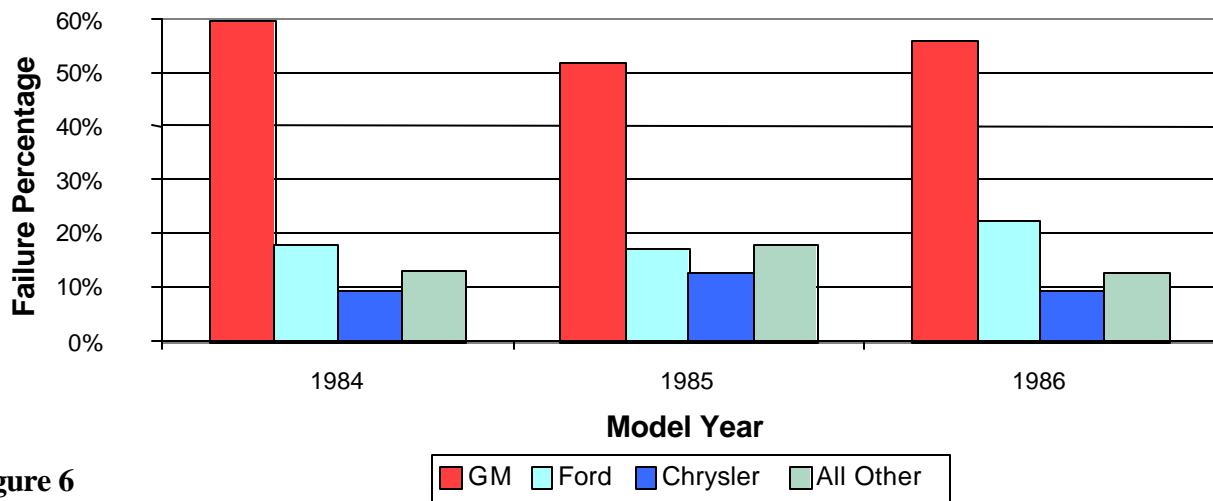


Figure 6

Percentage of Total GM Failures

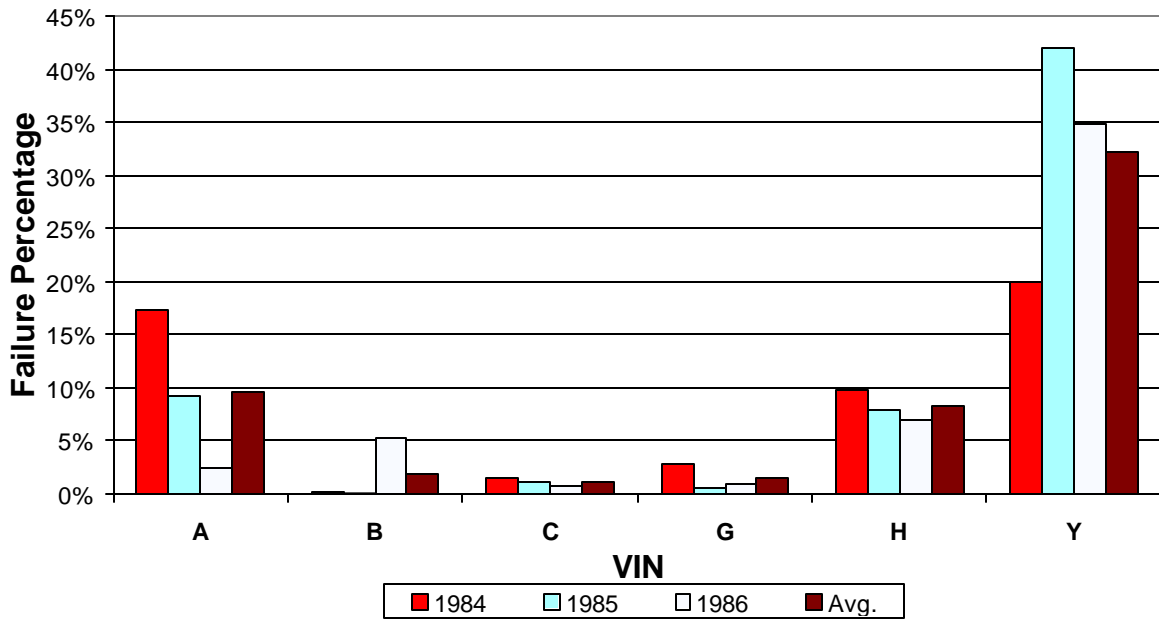


Figure 7 – Lesser VIN codes excluded

1st Retest Failure Rates VIN "Y" and "H"

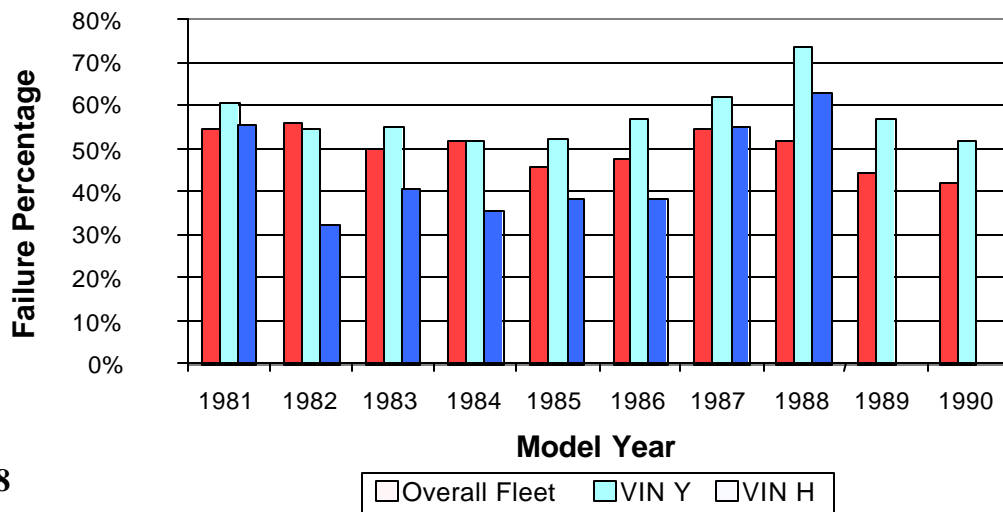


Figure 8

Prospective facilities were then contacted by phone. On-site interviews were scheduled with the facilities that showed an interest in participating in the study. The interview provided a detailed explanation of the prospective candidate's participation (see 'Methodology') and compensation (see Figure 9). The interview also provided an opportunity for the study administrator to evaluate the candidate's technical equipment for emission diagnosis and repair. Preferred facilities utilized the following equipment:

- Engine Analyzer
- Lab Scope
- Scan Tool
- Exhaust Gas Analyzer capable of analyzing a minimum of 4 exhaust gasses

Repair Facility Compensation

<ul style="list-style-type: none"> • Diagnose vehicles for a fee of \$90.00 • Charge \$35.00 per hour on a flat rate basis and retail cost per item for parts • Accept \$15.00 per hour for travel to and from the Technical Assistance Center with a maximum of 3 hours • Compensation to repair facility for participation in the study is fixed at \$50.00 per vehicle. • Reimbursement to the repair facility will be 30 to 60 days after vehicle repair is completed. • 20% of repairs, sales tax, and a \$40.00 administration fee will be paid by the vehicle owner on return of the vehicle to the owner. • Accurately complete all associated paperwork

Figure - 9

Figure 10 outlines the repair facilities that were subsequently chosen to participate in the study. Standard contract agreements (Appendix B) were completed for each participating facility.

Repair Facility	Repair Effectiveness (Jan. 98 to April 98)
Girards Service Center 3018 S. Chicago Ave. South Milwaukee, WI 53172 (414) 764-2030	41 vehicles retested with 100% passing
Nelson Carburetor and Automotive 1409 13th St. Racine, WI 53403 (262) 633-2822	53 vehicles retested with 98% passing
Patrick Automotive 4925 30th Ave. Kenosha, WI 53144 (262) 652-8292	18 vehicles retested with 100% passing
Jeff's Automotive 5261 S. Nicholson Ave. Cudahy, WI 53110 (414) 482-3080	32 vehicles retested with 100% passing

Figure - 10

Methodology

Guidelines and Procedures

Participating repair facilities followed these guidelines during the study:

- Repair facilities solicited the vehicle owner's participation by explaining the purpose, procedures, and reason for the study. Participating vehicle owners completed a standard contract agreement (Appendix C). In order to increase the volume of the target vehicles through the study, a promotional flyer was produced (Appendix D). The flyer was distributed to the Milwaukee - South, Racine, and Kenosha Emission Testing Stations. Station managers were instructed to distribute the flyers to prospective participants.
- Vehicle diagnosis was performed per WISETECH theory.
- Appropriate emission repairs were made to the vehicles per '**Vehicle Procedure**' below.
- Appointments were made to retest the vehicles at a Technical Assistance Center.
- This allowed full trace, back to back (preconditioning) tests to take place. This also reduced the variables caused by differing techniques between testing technicians.
- Vehicles were re-tested per '**Vehicle Procedure**' below. The project administrator was on call throughout the study to rectify any unforeseen situations and provide technical assistance.

Vehicle Procedure

- Emission failure was diagnosed per WISETECH theory.
- Any vehicle that had an engine mechanical problem was excluded (e.g. cylinder compression or valve train related problem). Repair of mechanical problems such as these are time-consuming and costly.
- Diagnosis information worksheet (Appendix E) was completed.
- Emission repairs were performed. To provide additional study data, catalytic converters were not replaced at this time.
- A testing appointment was scheduled, and the vehicle was driven to a TAC at the appointed time. To simulate the vehicle waiting in line, the engine was left running upon arrival. The normal testing environment was simulated by pulling the vehicle in front of the testing lane and shutting off the engine (Envirotest standard operating procedure). The testing technician entered the vehicle information, started the engine, and began the test.
- At the end of test 1, the engine was left running and the second test was performed as soon as possible.
- The vehicle was driven back to the repair facility, and catalytic converters were replaced at this time, if needed.
- An appointment was scheduled for a second series of tests on the vehicles that had catalytic converters replaced, and the previous testing procedure was repeated.
- The vehicle emission summary sheet was completed (Appendix F).
- The vehicle owner cost sheet (Appendix G) and the repair facility reimbursement sheet (Appendix H) were completed at this time, and they were forwarded to the project administrator.

Results

A total of 81 GM vehicles were studied.

- 64 Vin “Y” vehicles – excluding 4 vehicles rejected due to engine mechanical defects
- 17 Vin “H” vehicles - 0 Vehicles rejected due to engine mechanical defects

The information presented represents our specific target vehicles. This information does not represent all VIN “Y” and VIN “H” vehicles.

The **average cumulative repair costs** for these vehicles were:

- Vin “Y” \$488.53 including parts, labor and sales tax
- Vin “H” \$432.16

The **lowest repair costs** were:

- Vin “Y” \$110.88
- Vin “H” \$119.22

The **highest repair costs** were:

- Vin “Y” \$979.87
- Vin “H” \$880.55

In most cases, repairs were very near the current waiver amount of \$450 (Figure 11 and Figure 12)

Repair frequency is outlined in Figure 13 and Figure 14. Most of the vehicles in the study required repair in several areas. *Note: This information is not intended to replace diagnostic procedures.*

Model year data for the study vehicles is represented in Figure 15 and Figure 16.

Odometer data for the study vehicles is represented in Figure 17 and Figure 18.

Repair Costs for VIN "Y"

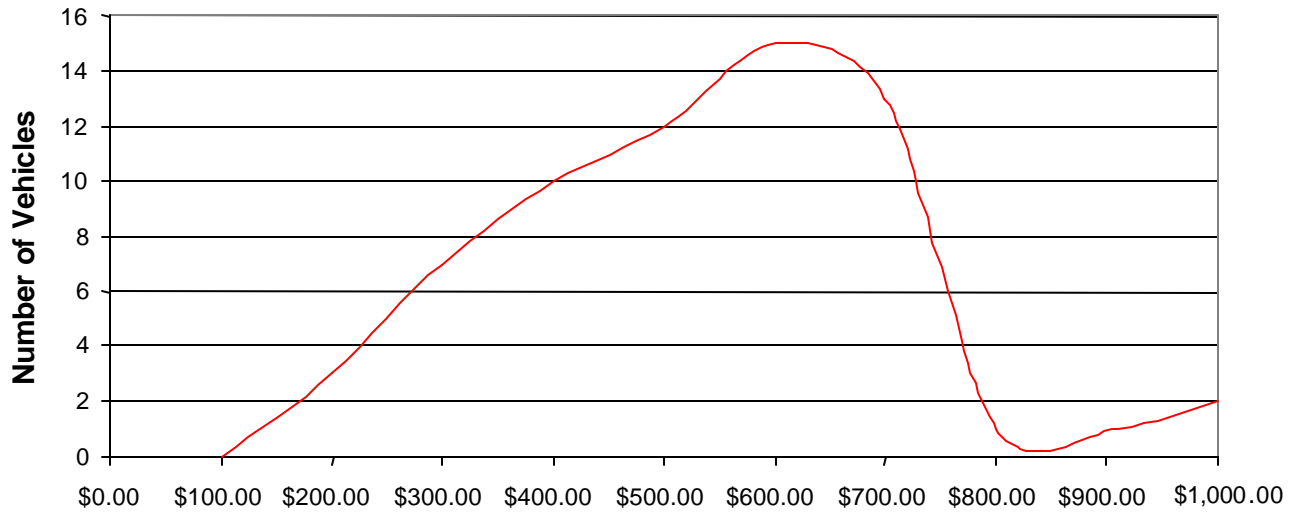


Figure 11 **Cost of Repairs**

Repair Costs for VIN "H" 17 Vehicles

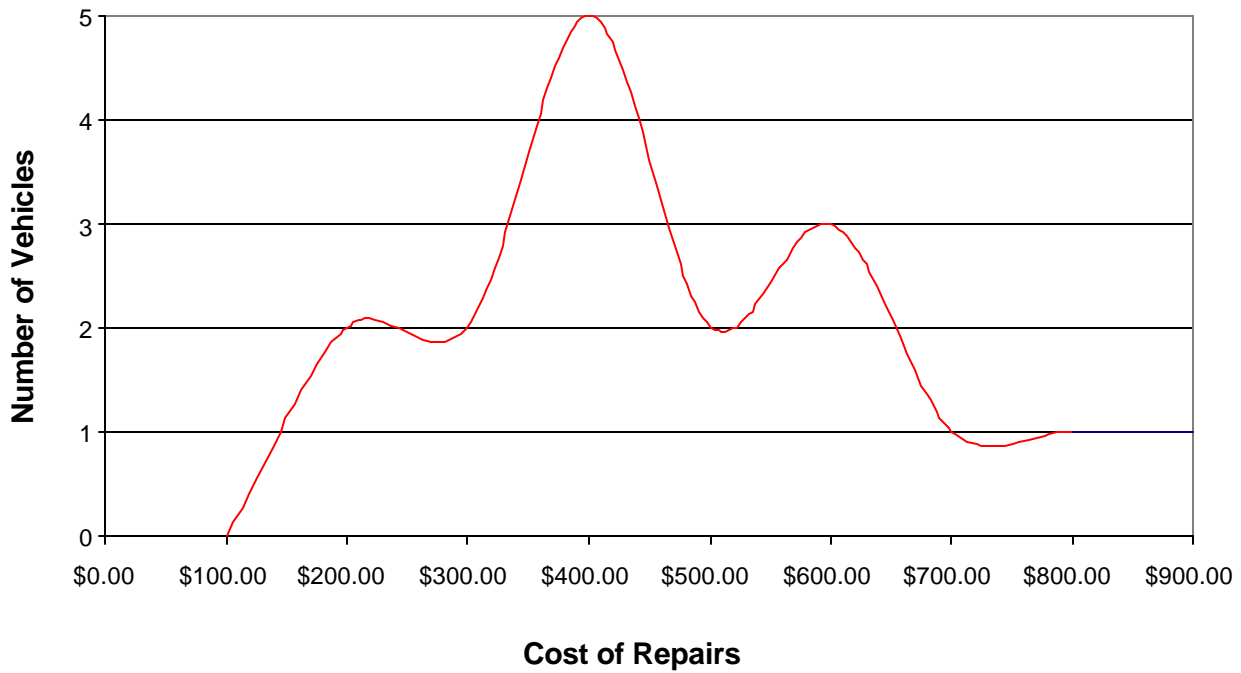


Figure 12

Repair Frequency for VIN 'Y' 64 Vehicles

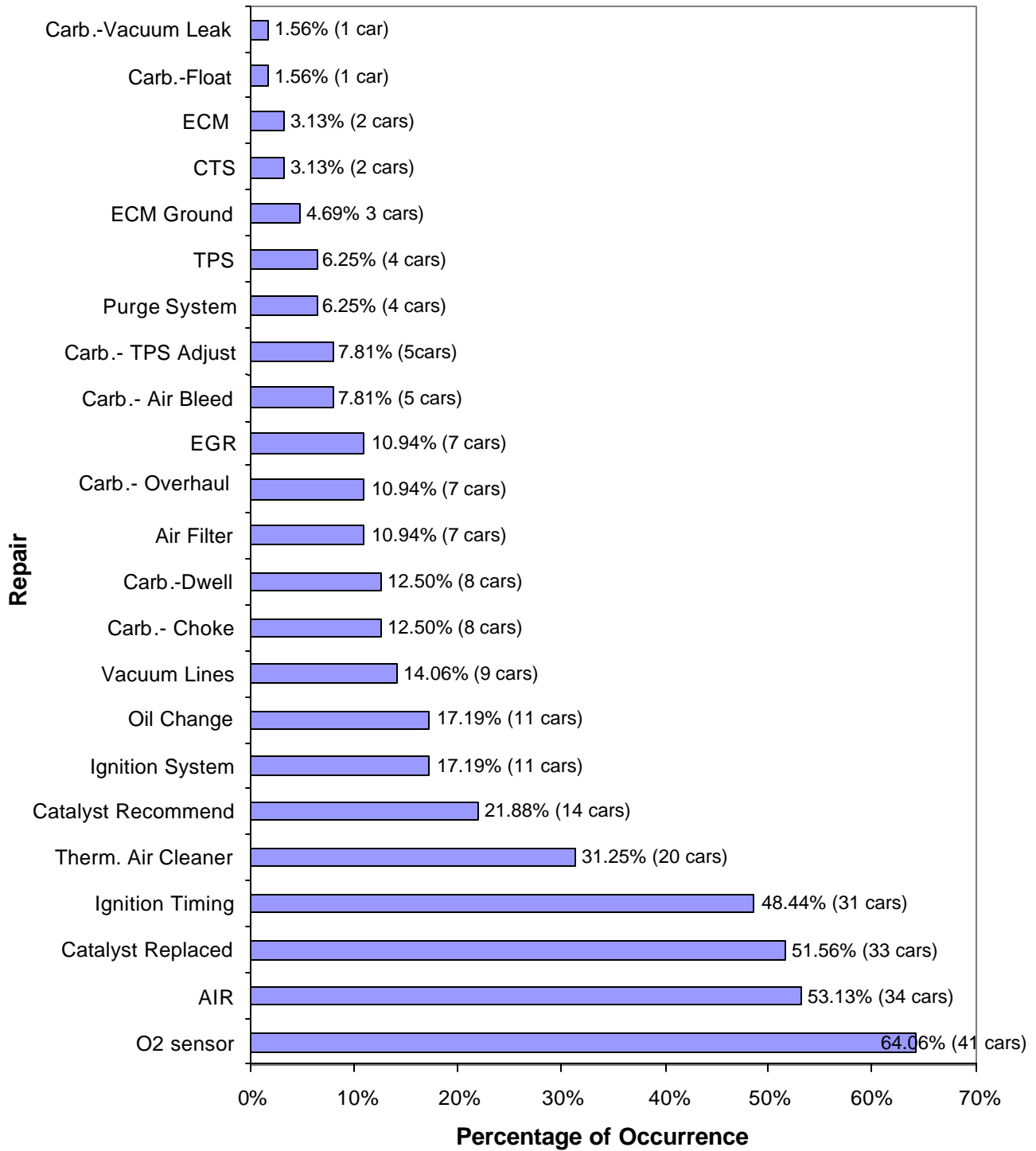


Figure 13

Repair Frequency for VIN "H" 17 Vehicles

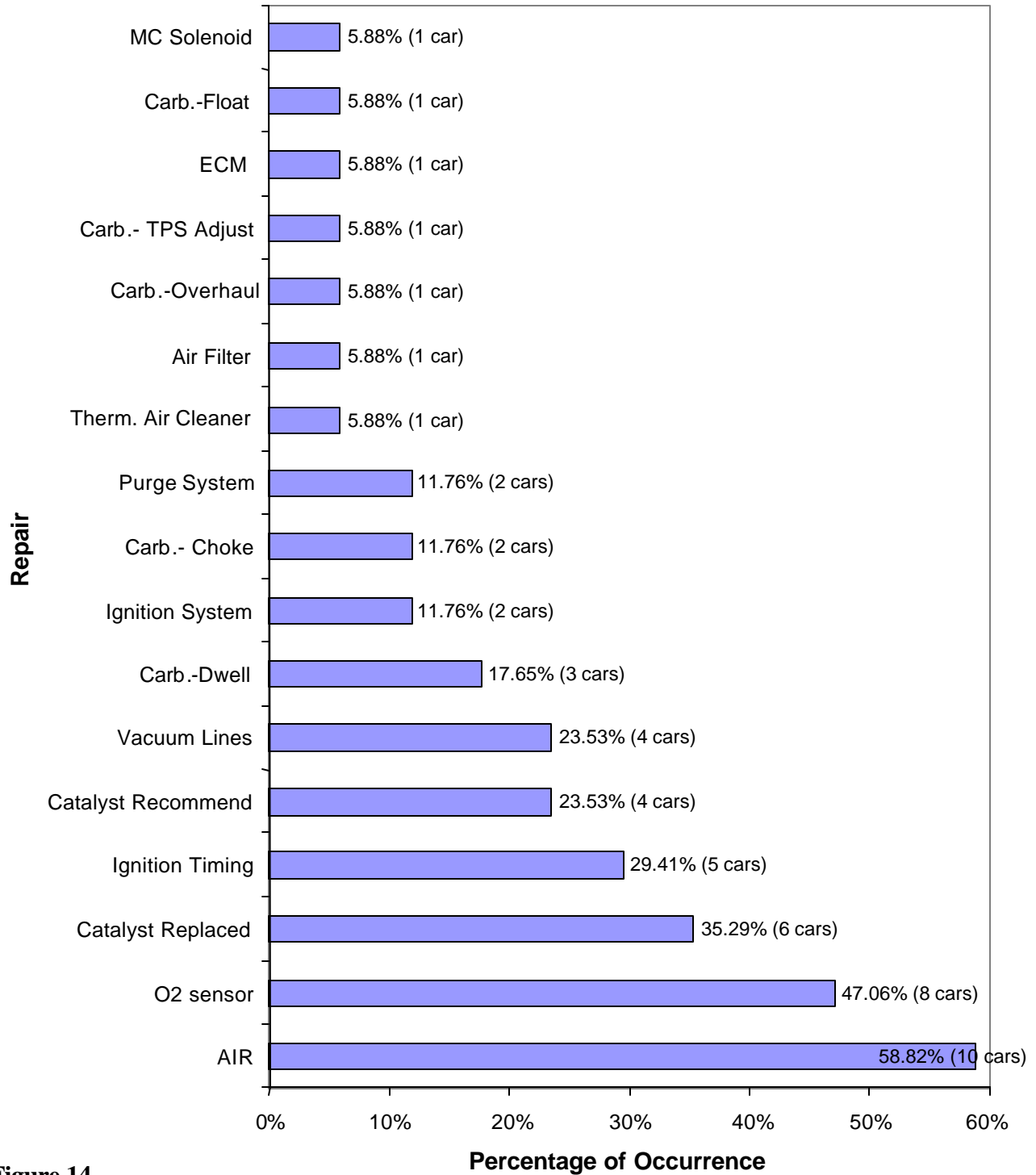


Figure 14

**Number of VIN "Y" Study Vehicles
64 Vehicles**

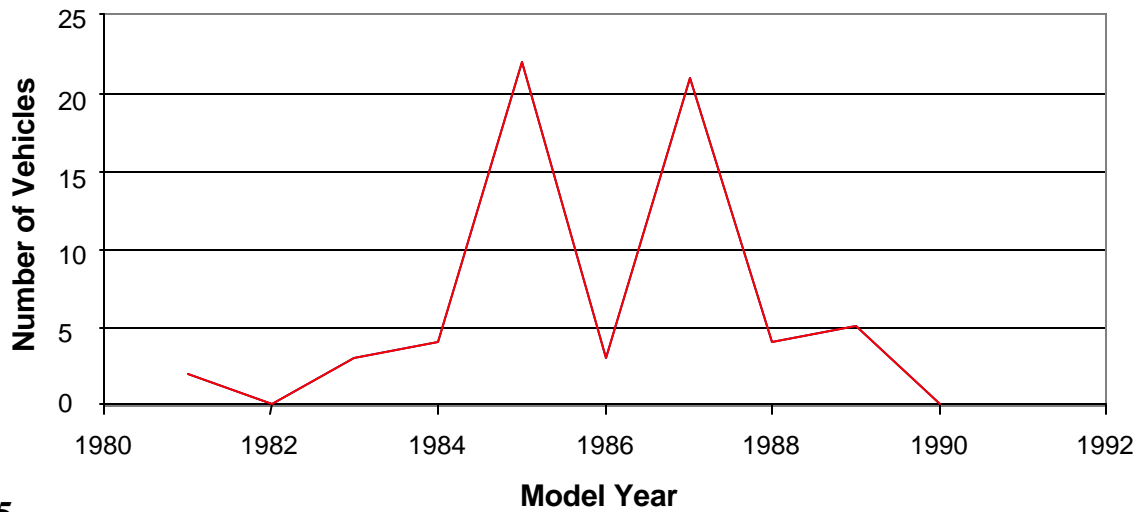


Figure 15

**Number of VIN "H" Study Vehicles
17 Vehicles**

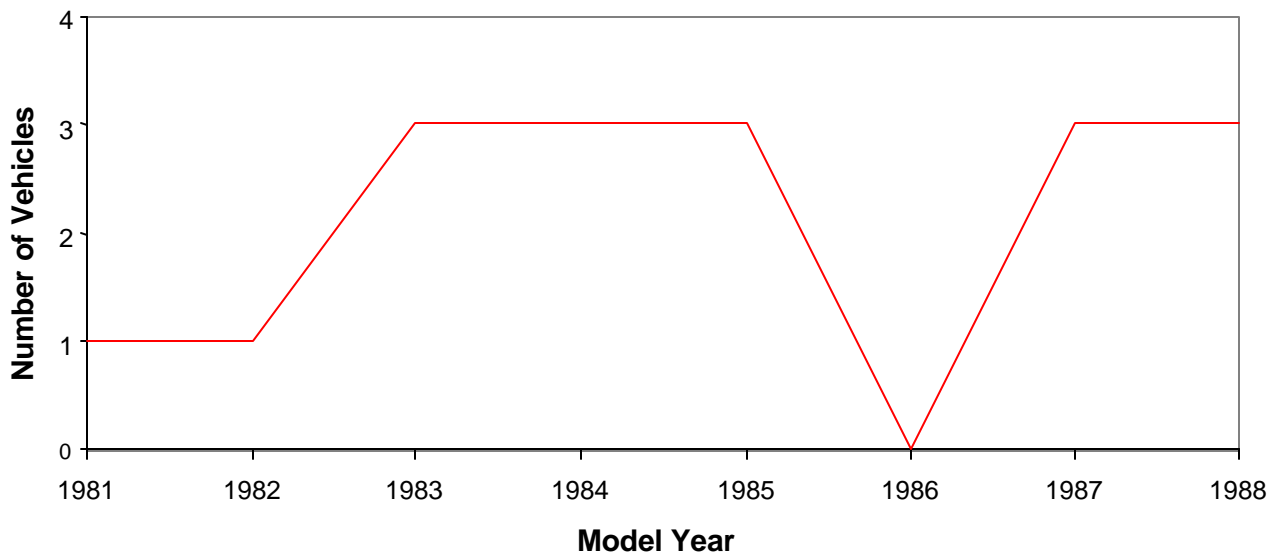


Figure 16

Mileage of VIN "Y" Study Vehicles 64 Vehicles

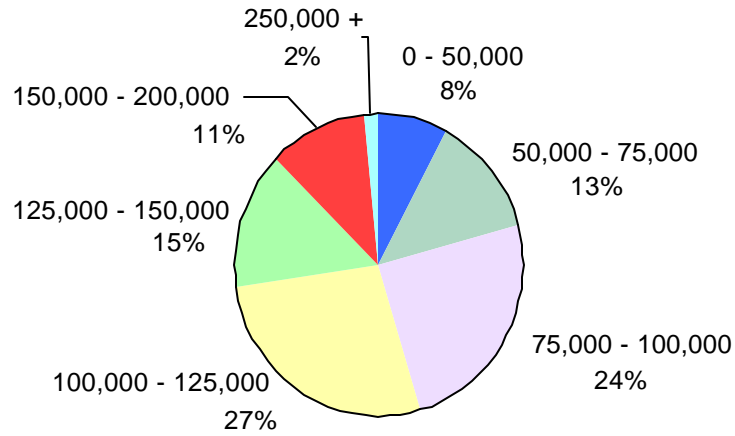


Figure 17

Mileage of VIN "H" Study Vehicles 17 Vehicles

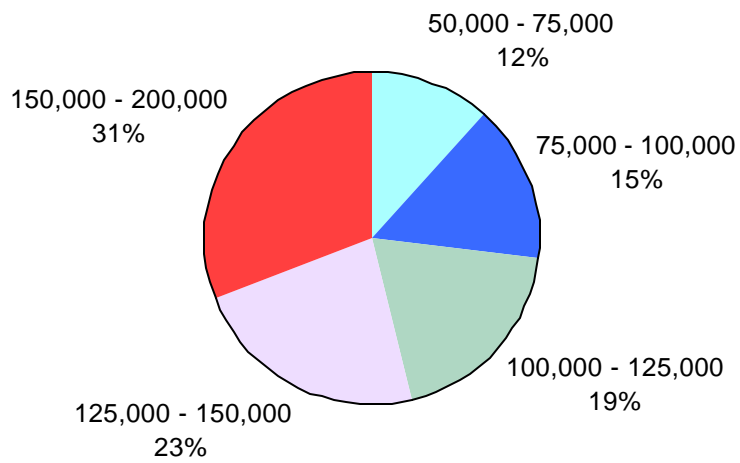


Figure 18

Effects of Preconditioning and Catalytic Converter Replacement

		% Pass Phase-in Cut points HC=2.0 CO= 60/30 NOx=3.0		%Pass Intermediate Cut points HC=1.3 CO= 20 NOx=2.5		% Pass Final Cut points HC=0.8 CO=15 NOx=2.0	
Action After Initial Failure & Repair	Number of Vehicles	HC+CO	HC, CO, & NOx	HC+CO	HC, CO, & NOx	HC+CO	HC, CO, & NOx
No Catalyst No preconditioning *	80	50%	34%	22%	16%	14%	9%
No Catalyst with Preconditioning *	80	70%	52%	44%	32%	20%	12%
Catalyst replaced No preconditioning	37	92%	84%	84%	73%	65%	51%
Catalyst replaced with preconditioning	37	100%	100%	92%	84%	81%	70%

Figure – 19

* - “No Catalyst” data was unavailable for one Vin “H” vehicle (Vehicle # 17). Please refer to Appendix ‘K’ for specific Vin code and model year group statistics.

Average Emissions of Fleet Failing VIN Y vs. Study Vehicles

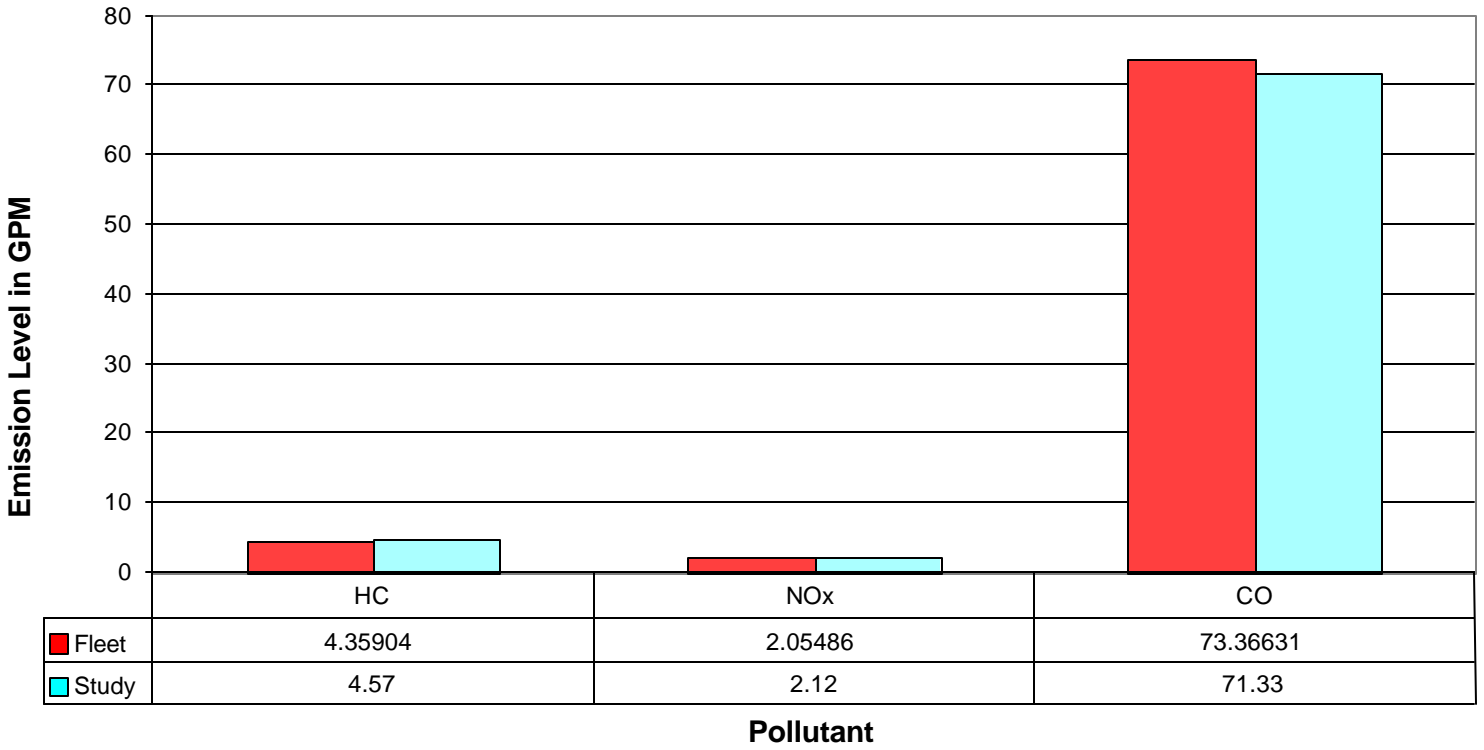


Figure 20

Average Emissions of Failing VIN "H" vs. Study

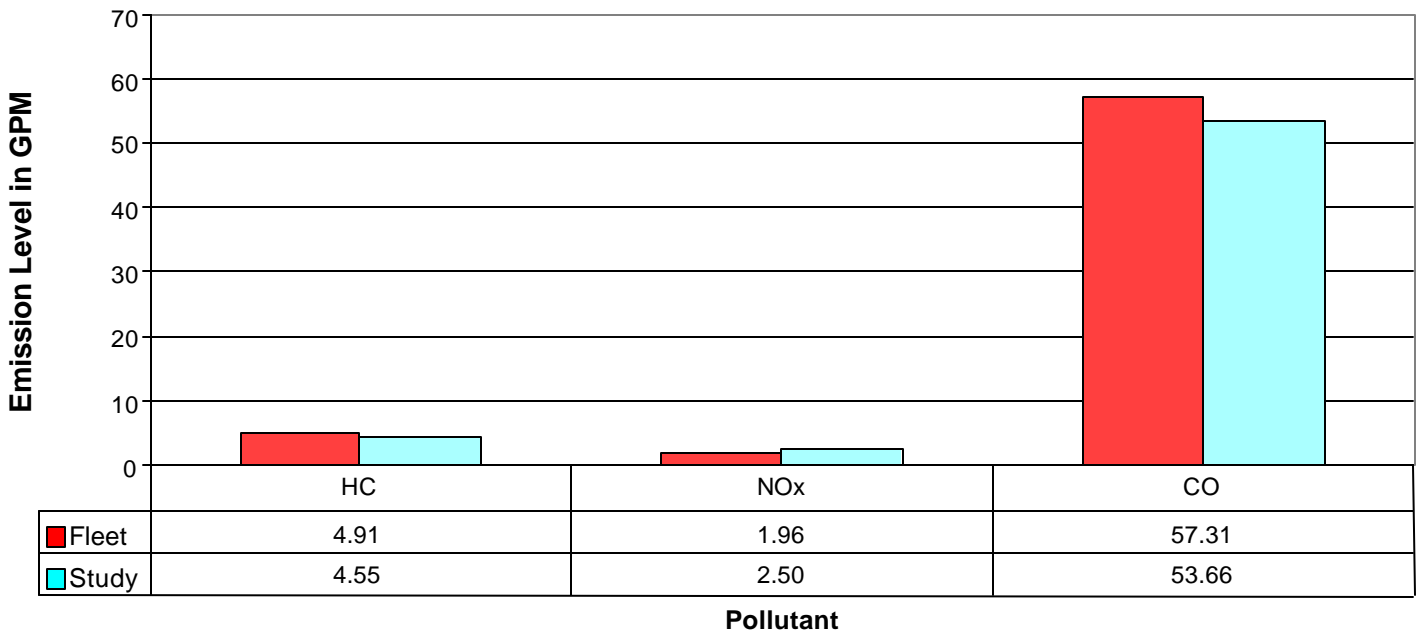


Figure 21

Passing Rates for VIN "Y" Study Vehicles at Current Cutpoints

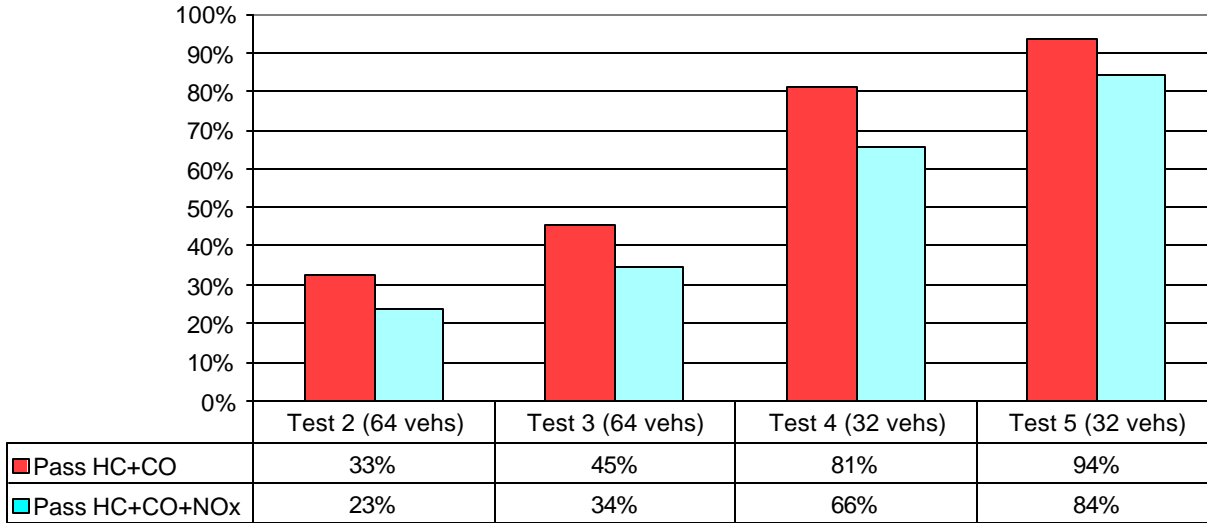


Figure 22

Average HC Emissions - All Study Vehicles

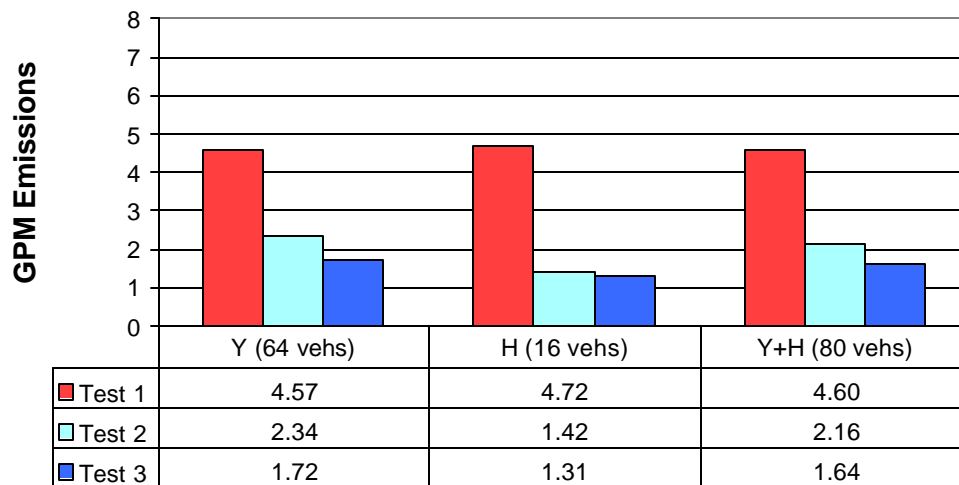


Figure 23

Average NOx Emissions - All Study Vehicles

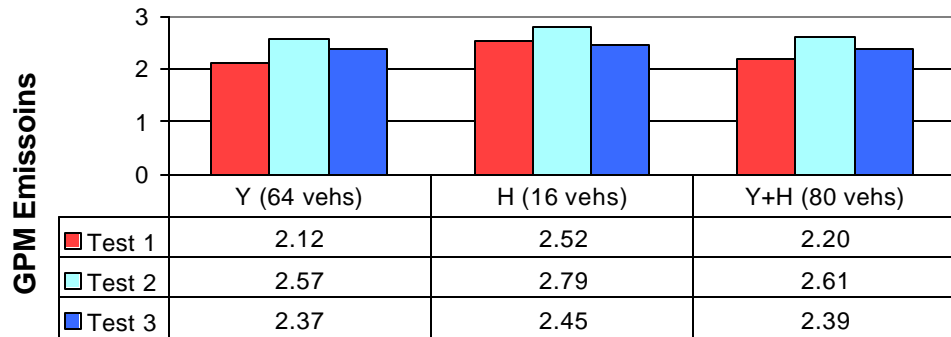


Figure 24

Average NOx Emissions - Study Vehicles that had Catalyst Replaces

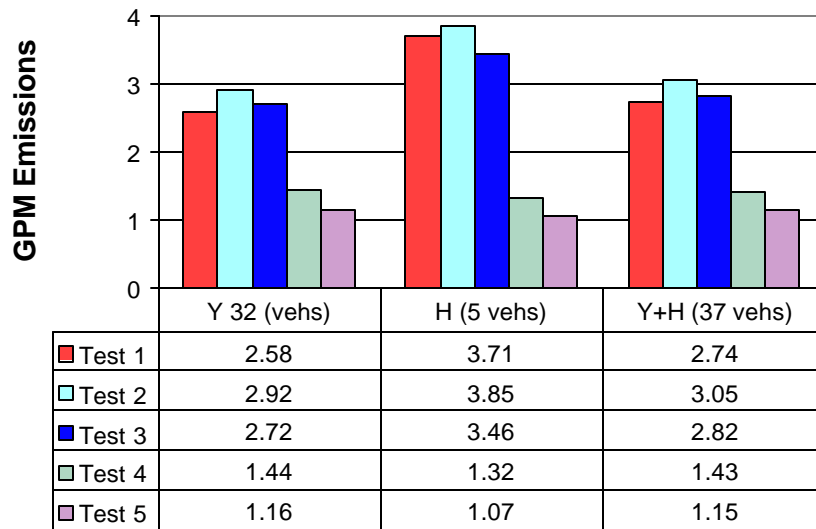


Figure 25

Definitions: Test 1: Most recent IM240 test prior to vehicle's recruitment into study
 Test 2: After repairs; Catalyst not replaced and no preconditioning
 Test 3: After repairs; Catalyst not replaced and preconditioning
 Test 4: After repairs; Catalyst replaced and no preconditioning
 Test 5: After repairs, Catalyst replaced and preconditioning

Average CO Emissions - Study Vehicles that had Catalyst Replaced

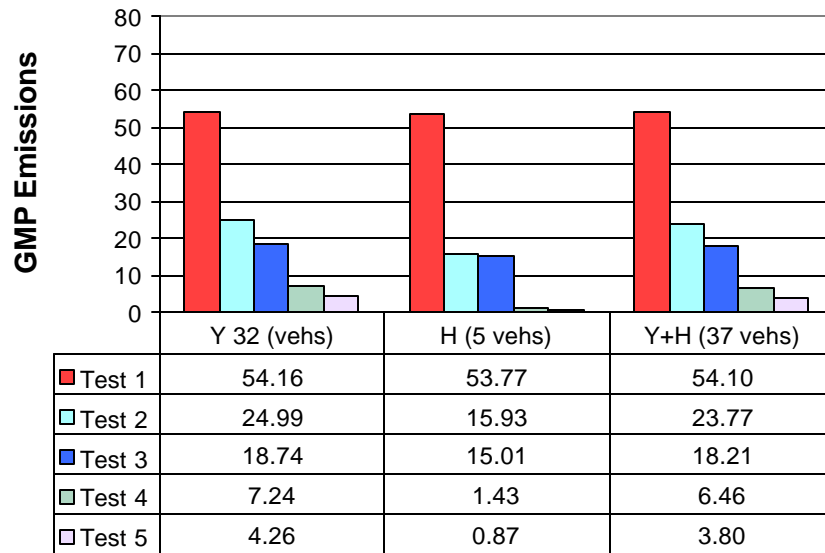


Figure 26

Definitions: Test 1: Most recent IM240 test prior to vehicle's recruitment into study
 Test 2: After repairs; Catalyst not replaced and no preconditioning
 Test 3: After repairs; Catalyst not replaced and preconditioning
 Test 4: After repairs; Catalyst replaced and no preconditioning
 Test 5: After repairs, Catalyst replaced and preconditioning

Passing Rates for VIN "Y" and VIN "H" Study Vehicles at Current Cutpoints

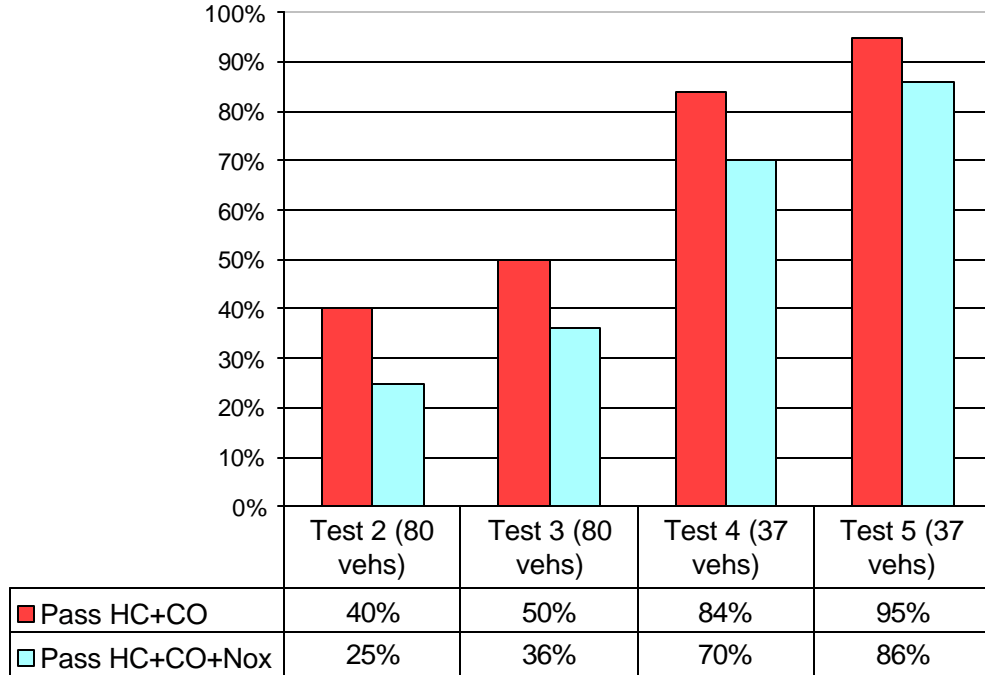


Figure 27

Definitions: Test 1: Most recent IM240 test prior to vehicle's recruitment into study
 Test 2: After repairs; Catalyst not replaced and no preconditioning
 Test 3: After repairs; Catalyst not replaced and preconditioning
 Test 4: After repairs; Catalyst replaced and no preconditioning
 Test 5: After repairs, Catalyst replaced and preconditioning

"Current cutpoints" are "phase-in" cutpoints for model years 1981-1986 and "final" cutpoints for model years 1987-1989.

Average HC Emissions - Study Vehicles that had Catalyst Replaced

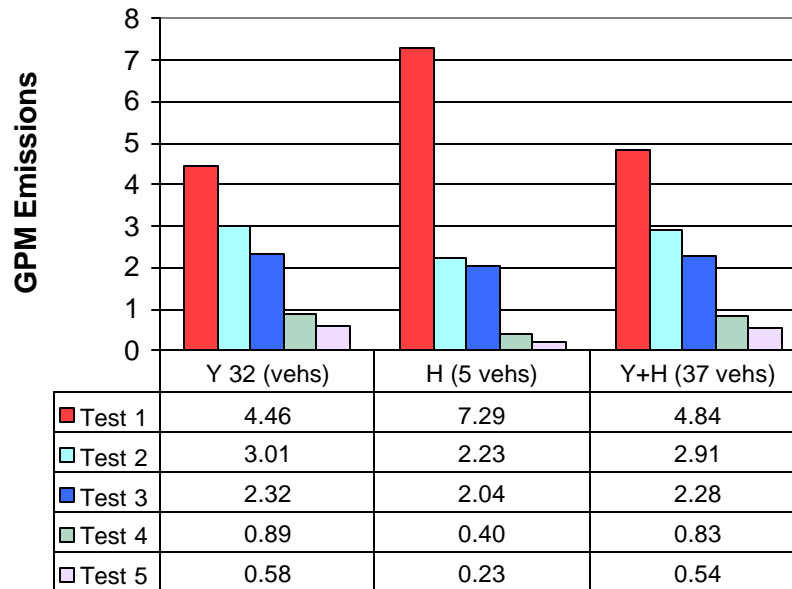


Figure 28

Definitions: Test 1: Most recent IM240 test prior to vehicle's recruitment into study
 Test 2: After repairs; Catalyst not replaced and no preconditioning
 Test 3: After repairs; Catalyst not replaced and preconditioning
 Test 4: After repairs; Catalyst replaced and no preconditioning
 Test 5: After repairs, Catalyst replaced and preconditioning

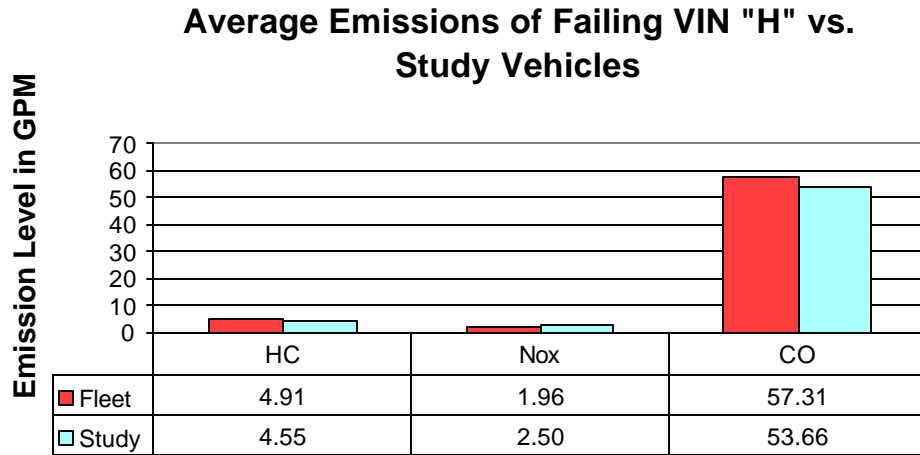


Figure 29

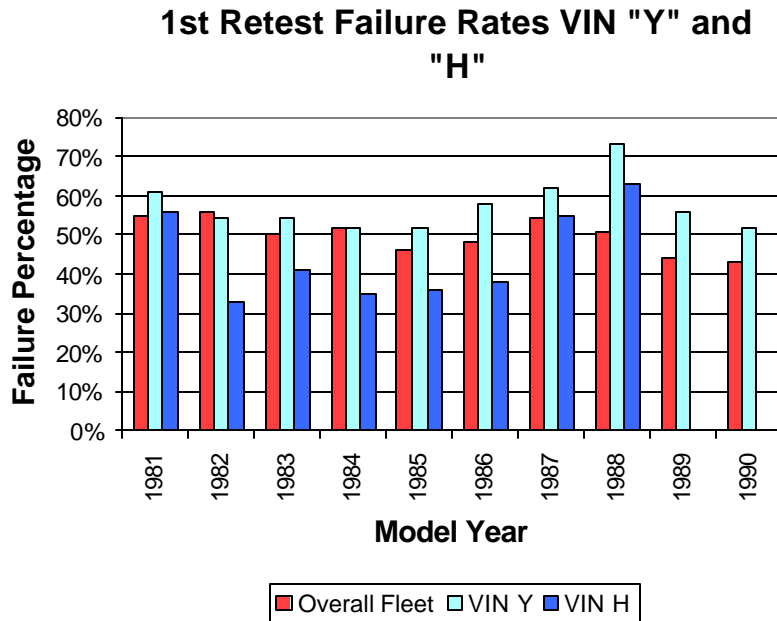


Figure 30

Passing Rates for VIN "Y" Study Vehicles at Current Cutpoints

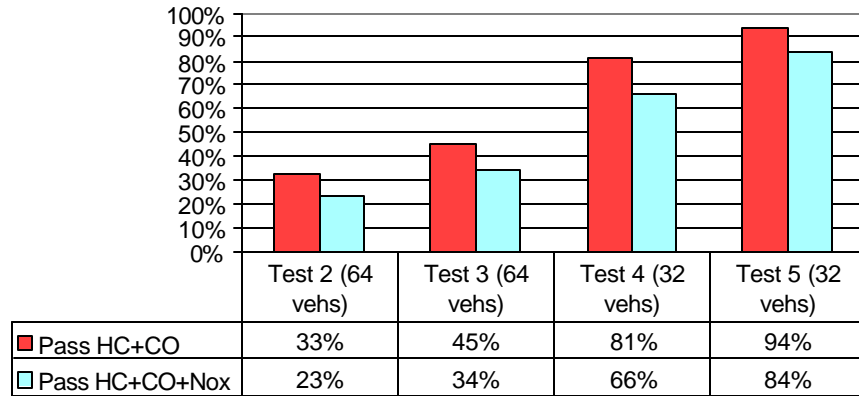


Figure 31

Passing Rates for VIN "H" Study Vehicles at Current Cutpoints

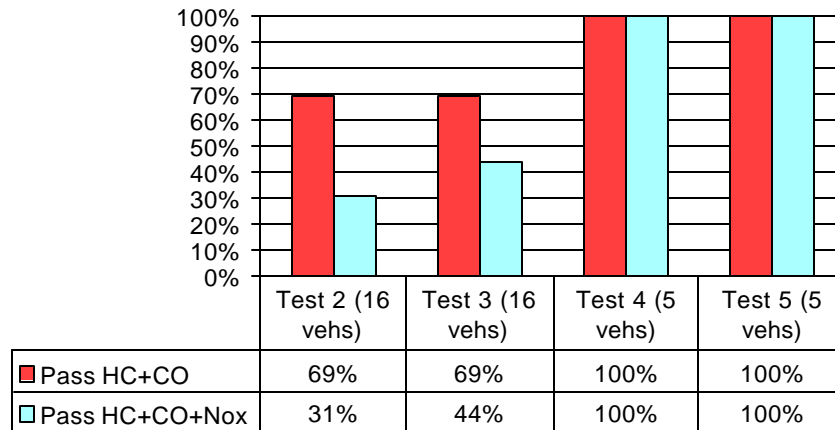


Figure 32

- Definitions:
- Test 1: Most recent IM240 test prior to vehicle's recruitment into study
 - Test 2: After repairs; Catalyst not replaced and no preconditioning
 - Test 3: After repairs; Catalyst not replaced and preconditioning
 - Test 4: After repairs; Catalyst replaced and no preconditioning
 - Test 5: After repairs, Catalyst replaced and preconditioning

Conclusions

The effectiveness of the WISETECH-educated repair technicians participating in the study easily exceeded Wisconsin State effectiveness statistics for aftermarket emission repair facilities reported in the 1999 Wisconsin Department of Transportation Blue Book. This comparison verifies the hypothesis that the effectiveness of aftermarket emission repair is a determining factor in the increased level of emission test failures in southeastern Wisconsin.

- **Repair Frequency Data:** The repair frequency data that was obtained will be useful in developing repair guidelines. These types of repairs are not difficult to diagnose and perform if the technician understands the functions and can effectively check and test these systems. The informed technician will have a greater opportunity to offer cost-effective emissions diagnosis and repair to the motorist.
- **WISETECH Training Effectiveness:** WISETECH graduates effectively performed emission repairs on the study vehicles to achieve a 100% I/M 240 pass rate at “phase-in” cutpoints and a 95% pass rate at current cutpoints. This is a good indication that the procedures and techniques covered in the WISETECH curriculum are effective.
- **Future Emission Limits and Repair Waivers:** The repair cost data reported in this study will be helpful in examining future repair waiver limits. The average repair cost was only marginally higher than the current waiver amount. Wisconsin DNR in-depth analysis of study data (Appendix ‘K’) also concluded:
 1. The results suggest that the effectiveness of repairs is somewhat better for Vin “H” vehicles than for Vin “Y” vehicles.
 2. The results suggest that the preconditioning effect is stronger for Vin “Y” vehicles than for Vin “H” vehicles. That is, the drop in emissions after preconditioning is larger for Vin “Y” vehicles
 3. Non-catalyst repairs to the study vehicles increased NOx emissions by 12% to 21%. Catalyst replacement on these vehicles achieved NOx reductions of 44% to 55%.
 4. Catalyst replacement is necessary to achieve a high retest pass rate. Although significant HC and CO reductions can be achieved prior to catalyst replacement (49% to 62% HC ; 72% to 79% CO), catalyst replacement leads to even larger reductions (80% to 87% HC ; 87% to 92% CO). Catalyst replacement is often necessary to enable a vehicle to pass the I/M 240 test.
 5. Prior to catalyst replacement, less than one half of the study vehicles passed the I/M 240 test at the current cutpoints. After catalyst replacement the pass rate increased to 94% without recommended NOx pass/fail cutpoints, and 84% passing with NOx pass/fail cutpoints in place.
 6. Implementing pass/fail for NOx using the current recommended cutpoints will decrease the retest pass rate by approximately 10%. (Similar results are expected across the vehicle fleet.)
 7. At the I/M program’s current cutpoints, a smaller percentage of 1987 – 1989 model year vehicles pass the test after repairs than the 1981 – 1986 model year vehicles. All of the 1981 –

1986 vehicles meet current cutpoints for HC, CO, and NO_x after catalyst replacement and preconditioning. 10% of the 1987 – 1989 model year vehicles fail to meet current cutpoints after catalyst replacement and preconditioning. When NO_x pass/fail is added, this failure rate increases to 25%.

Conclusions (Cont.)

8. Preconditioning the vehicle significantly lowers the I/M 240 emission reading. The reductions achieved with preconditioning are greater for HC and CO than for NO_x. All three pollutants are reduced significantly after catalyst replacement.

- **Cost of Repairs**

Many motorists want to spend the minimum on their vehicles to pass inspection. Subsequently, if the waiver amount (\$450) has been spent, the repairs stop and the application for a waiver continues. To complete the repairs, the catalytic converter needs replacement in most cases. The cost of this replacement puts the total repair cost well in excess of the waiver amount, and the repair is most often declined in favor of a waiver.

Recommendations

- A follow-up study should be conducted to determine the durability of the emission repairs performed on the vehicles in this study.
- Further studies should be considered to develop make and model specific diagnosis and repair procedures. Time and budget constraints did not allow this study to go in depth in this area.
- Up-to-date, vehicle-specific repair information should be regularly distributed directly to the automotive repair technicians who are repairing these vehicles. All effective distribution methods should be considered.
- The WISETECH training program should be strongly promoted in the local automotive repair community on a regular basis.
- An informal consensus of technicians participating in the study suggests that emissions-related outreach information should be distributed directly to vehicle owners. This information should include terminology definitions and a comprehensive I/M 240 test overview.
- Cutpoints for model years 1980 – 1986 should remain at the current level. If these cutpoints are lowered, the failure rate will increase substantially.
- The current waiver amount should be re-examined to determine if a slight increase would be effective in bringing a significant number of waived vehicles into compliance.
- A phase-in of NOx cutpoints for older vehicles should be considered to avoid an increase in I/M 240 fail rates for older vehicles.
- The Wisconsin I/M program should continue the effort to investigate and develop effective repair strategies for older vehicles. Additional focus should be given currently to the 1987 and newer model year vehicles.
- The Wisconsin I/M program should continue the policy of second chance testing to avoid false failures resulting from a lack of preconditioning.

Appendix A

1. **Phase-in Cutpoints** (HC = 2.0 gpm all model years, CO = 60 gpm model years up to 1982 / 30 gpm model years 1983 and newer, NO_x = 3.0 gpm all model years.) Wisconsin's inspection and maintenance (I/M) program has been using these cutpoints for model years 1981 – 1986 passenger cars since December 1, 1996. Between December 1, 1996 and December 31, 1997, these cutpoints were also used for model years 1987 – 1990 passenger cars.
2. **Intermediate Cutpoints** (HC = 1.3 gpm, CO = 20 gpm, NO_x = 2.5 gpm). Wisconsin's I/M program had planned to use these cutpoints for model years 1983 – 1986 passenger cars starting December 1, 1999. (Cutpoints slightly more lenient than the intermediate cutpoints were also planned for model years 1981 and 1982 passenger cars starting December 1, 1999.) The Wisconsin Department of Natural Resources has subsequently revised regulations to keep the phase-in cutpoints indefinitely for model years 1981 – 1986 passenger cars.
3. **Final Cutpoints** (HC = 0.8 gpm, CO = 15 gpm, NO_x = 2.0 gpm). Wisconsin's I/M program has been using these cutpoints for model years 1991 – 1996 passenger cars since January 1, 1998, and for model years 1987 – 1990 passenger cars since December 1, 1998.

Appendix B

Agreement Between Gateway Technical College and *(named repair facility)*

Wisconsin Department of Natural Resources Bureau of Air Management and Gateway Technical College are conducting a repair effectiveness study on a selected number of engine family vehicles through automotive repair facilities employing WISETECH graduates. In order to solidify vehicle owner participation in the study, the DNR (through a CMAQ grant) will pay for 80% of the emission repairs on the vehicle with a maximum amount of \$450.00 parts and labor. This study is designed to achieve the following objectives:

1. Provide pertinent information to the repair industry so that they have the best opportunity to offer cost-effective emission related diagnosis and repairs to the motorist.
2. Evaluate the effectiveness of the WISETECH program curriculum
3. Provide a basis to determine Wisconsin's policy on future emission limits

(named repair facility) has been selected to participate in the study based on the following criteria:

1. WISETECH employed graduate(s)
2. Facility repair effectiveness index
3. Equipment available to diagnose and repair emission failures
4. Probability of the target vehicles to arrive at your facility

(named repair facility) agrees to participate in the study and to correctly follow these guidelines and procedures outlined for the study:

1. Solicit the vehicle owner's participation in the study
2. Exclude any vehicle that has an engine mechanical problem
3. Conduct the vehicle diagnosis
4. Make appropriate emission repairs to vehicle
5. Accurately complete all associated paperwork
6. Have vehicle testing conducted at Technical Assistance Centers
7. Contact project administrator to rectify any unforeseen situations, technical assistance, and when vehicle has completed the study
8. Diagnose vehicles for a fee of \$90.00
9. Charge \$35.00 per hour on a flat rate basis and retail cost per item for parts
10. Accept \$15.00 per hour for travel to and from the Technical Assistance Center with a maximum of 3 hours

Appendix B (cont.)

- 11. Compensation to repair facility for participation in the study is fixed at \$50.00 per vehicle.
- 12. Reimbursement to the repair facility will be 30 to 60 days after vehicle is completed.
- 13. 20% of repairs up to a limit of \$450, 100% of repairs exceeding the \$450 limit, sales tax, and a \$40.00 administration fee will be paid by the vehicle owner on return of the vehicle to the owner.

The administrator of the project may cancel this agreement at any time and will stay in contact with the repair facility as to when sufficient data have been collected and the study is concluded.

The parties hereto have executed this agreement:

(named repair facility)

By: _____
Title: _____
Date: _____

Gateway Technical College

By: _____
Title: _____
Date: _____

Appendix C

Agreement Between *(named repair facility)* and Vehicle Owner

Wisconsin Department of Natural Resources Bureau of Air Management and Gateway Technical College are conducting a repair effectiveness study on a selected number of engine family vehicles through automotive repair facilities employing WISETECH graduates. In order to solidify vehicle owner participation in the study, the DNR (through a CMAQ grant) will pay for 80% of the emission repairs on the vehicle with a maximum amount of \$450.00 parts and labor. This study is designed to achieve the following objectives:

1. Provide pertinent information to the repair industry so that they have the best opportunity to offer cost-effective emission related diagnosis and repairs to the motorist.
2. Evaluate the effectiveness of the WISETECH program curriculum
3. Provide a basis to determine Wisconsin's policy on future emission limits

The vehicle owner agrees to participate in the study and will abide by the guidelines of the study.

1. If my vehicle is found to have an engine mechanical problem, it will be excluded from the study and I am responsible for the full amount of the diagnostic fees charged by the repair facility.
2. The study will only pay for emission repairs necessary to meet emission standards and any other repairs are the full responsibility of the vehicle owner.
3. Any authorized repairs that exceed the \$450.00 limit of the study are the full responsibility of the vehicle owner.
4. I understand that the guidelines of the study may require my vehicle to be kept at the repair facility for 2 to 3 days. If I choose to remove my vehicle from the study prematurely, the charges are the full responsibility of the vehicle owner.
5. I authorize a representative of the repair facility to drive my vehicle to a Technical Assistance Center for a maximum of 2 round trips. Gasoline is the vehicle owners responsibility.
6. Upon completion of the vehicle in the study, the financial responsibility of the vehicle owner is 20% of emission repairs up to \$450.00, 100% of all repairs over \$450.00, sales tax of the total repair invoice, and a \$40.00 administration fee. **Example:** Repair invoice = \$448.38. 20% of \$425.00 subtotal = \$85.00 plus tax of 5.5% = \$23.38 plus adm. fee of \$40.00 equals \$148.38 that the owner pays.

The parties hereto have executed this agreement:

Vehicle Owner

Name: _____ Signature: _____ Date: _____

Address: _____ City, ZIP: _____ Phone # _____

(named repair facility)

By: _____ Date: _____

Appendix D

**Gateway Technical College
and
Wis. Department of Natural
Resources
are conducting a
Repair Effectiveness Study
and your vehicle may be eligible to
participate in this study.**

*The study will pay for 80% of your
repair bill.*

**For further information concerning
the study, please contact
Steve Kukawka
at Gateway Technical College
(414) 631-1020**

Appendix E

Diagnosis and Repair Worksheet

Directions: Please write out any adjustments, procedures, and parts replaced during your diagnosis and repair of the project vehicle with an explanation of why these operations were performed.

Example: Replaced ignition wire set because #6 plug wire indicated open circuit on ignition scope and other wires appear to be original; Overhauled carburetor, well plugs leaking.

Appendix F

Vehicle Emission Summary Sheet

Year: _____
Make: _____
Model: _____
Mileage: _____
Engine: _____
VIN: _____
License Plate _____

All readings in Grams/mile	As received Readings	Intermediate Readings			Final Readings	
	Test #1	Test #2	Test #3	Test #4	Test #5	
HC						
CO						
NO _x						

Appendix G

Vehicle Owner Cost Worksheet

Sub-Total of repair invoice \$ _____ **X .20 (20%) =** _____

Note: If Sub-Total is over \$450.00 enter \$450.00.

Authorized repairs over \$450.00. Sub-Total minus \$450.00 = _____

Sales tax of the total repair invoice = _____

Project Administration Fee = **\$40.00**

Final cost to the vehicle owner for emission repairs = _____

Appendix H

Repair Facility Reimbursement Worksheet

(Named Repair Facility)

Address

City, State ZIP

Phone number

Sub-Total of repair invoice \$ _____ X .80 (80%) = _____

Time to and From TAC. _____ Hours X \$15.00 = _____

Participation Compensation = **\$50.00**

Sub-Total = _____

Less Administration Fee collected from vehicle owner - **\$40.00**

Total Reimbursement to the Repair Facility for Emission Repairs of Project Vehicle. = _____

Appendix I – Vin H Raw Numbers

#	YEAR	MILEAGE	HC					CO				
			TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
1	1983	183,700	12.38	0.15	0.24			18.44	11.26	16.03		
2	1984	68,524	3.13	2.28	2.42			27.41	18.58	21.97		
3	1983	147,212	3.58	0.52	0.60			83.57	5.29	5.58		
4	1985	61,481	1.48	1.73	1.42			44.54	23.48	22.20		
5	1985	148,506	3.17	2.30	2.20	0.88	0.57	42.41	11.90	11.52	3.07	1.42
6	1985	NA	1.25	0.53	0.36			67.38	9.85	12.98		
7	1987	97,000	1.50	0.39	0.46			2.05	1.46	2.00		
8	1984	66,390	3.42	1.59	1.61			20.15	15.52	17.22		
9	1983	119,128	2.06	1.52	1.17			14.50	5.37	5.89		
10	1981	111,377	3.71	3.49	3.27	0.38	0.02	117.27	22.64	13.87	2.84	0.46
11	1984	72,307	23.22	1.66	1.55	0.11	0.12	39.34	19.87	27.63	0.38	2.02
12	1982	88,000	6.50	1.84	1.73			312.74	15.34	16.57		
13	1987	78,245	3.65	2.15	2.00	0.34	0.22	57.99	17.38	14.19	0.71	0.24
14	1987	96,635	1.86	0.45	0.38			12.62	0.89	1.25		
15	1988	153,760	1.85	0.61	0.37			24.12	3.37	2.27		
16	1988	109,000	2.70	1.56	1.16	0.28	0.23	11.85	7.87	7.85	0.16	0.19
17	1988	85,000	1.85			0.0027	0.484	15.83			0.3933	7.7215
	1984.94	105,392	4.55					53.66				

Appendix I (Cont.)

NOx				
TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
2.71	1.49	1.21		
1.18	1.14	1.02		
0.89	1.05	0.95		
2.08	2.80	2.81		
4.85	3.60	3.44	1.05	0.85
0.33	1.09	0.82		
2.02	4.11	2.35		
4.57	3.32	3.39		
4.04	4.23	3.63		
1.50	5.12	5.65	0.93	0.11
5.02	3.85	1.40	2.05	2.03
0.18	3.24	2.89		
1.83	4.08	4.17	1.18	1.11
2.92	2.49	2.40		
0.80	0.38	0.52		
5.35	2.59	2.62	1.38	1.25
2.24			0.0212	0.4942
2.50				

Sub -total \$	Owner add.	Sales Tax	Total Cost	Cat Cost Portion of Total
\$154.50		\$8.66	\$163.16	
\$450.00	\$77.17	\$29.52	\$556.69	
\$366.68		\$20.17	\$386.85	
\$450.00	\$33.29	\$29.18	\$512.47	
\$450.00	\$384.64	\$45.91	\$880.55	\$239.00
\$450.00	\$133.82	\$34.81	\$618.63	
\$113.00		\$6.22	\$119.22	
\$264.15		\$13.47	\$277.62	
\$298.60		\$18.84	\$317.44	
\$450.00	\$110.58	\$34.56	\$595.14	\$138.95
\$293.75		\$15.49	\$309.24	\$176.00
\$450.00	\$254.09	\$42.08	\$746.17	
\$402.61		\$26.77	\$429.38	\$164.57
\$255.48		\$12.77	\$268.25	
\$357.04		\$19.64	\$376.68	
\$419.10		\$22.31	\$441.41	\$191.50
\$331.00		\$16.88	\$347.88	\$185.00
			\$432.16	

Appendix J – Vin Y Raw Numbers

#	YEAR	MILEAGE	HC				
			TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
1	1987	81,414	4.01	0.54	1.54		
2	1987	101,500	3.95	2.76	2.70	0.27	0.37
3	1989	100,860	1.55	0.59	0.65		
4	1987	70,658	2.46	2.01	2.39	0.25	0.31
5	1985	104,745	2.52	1.12	0.47		
6	1987	94,300	3.20	3.01	2.52	1.07	0.69
7	1985	165,986	1.03	0.78	0.53	0.21	0.19
8	1983	165,359	12.83	1.47	0.75		
9	1985	135,069	8.49	3.16	2.30		
10	1985	132,782	5.22	2.41	0.85		
11	1985	34,421	1.95	2.33	1.43	0.42	0.49
12	1987	146,000	3.60	1.59	0.99		
13	1987	116,000	2.77	1.48	1.14	0.54	0.39
14	1985	147,000	2.40	1.08	1.20		
15	1988	78,000	4.90	5.10	4.60	2.40	1.70
16	1987	70,097	2.96	0.72	0.66		
17	1986	118,659	8.08	1.56	1.84		
18	1985	122,000	3.01	3.16	2.90	1.48	1.12
19	1987	122,006	6.10	3.55	2.22	0.55	0.31
20	1987	45,000	3.82	3.17	1.40	0.77	0.58
21	1988	54,428	2.79	0.88	0.53		
22	1986	110,000	8.11	1.98	1.08		
23	1985	81,000	5.00	1.05	1.07		
24	1985	122,888	3.65	1.75	1.21		
25	1987	77,252	9.08	2.80	2.51	0.42	0.21
26	1985	106,000	2.55	1.56	1.82		
27	1985	31,692	2.60	1.67	0.13		
28	1987	78,950	7.72	3.96	0.96	0.79	0.42
29	1981	93,415	2.80	2.69	2.58	0.48	0.26
30	1987	116,134	3.45	0.81	0.70		
31	1985	125,000	5.11	3.04	1.29		

CO				
TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
87.97	1.71	18.84		
29.12	22.01	28.64	3.04	0.72
60.47	19.45	12.22		
26.41	20.00	26.13	0.99	1.22
52.95	18.28	8.21		
12.27	17.43	14.00	7.34	2.19
48.24	24.48	18.27	1.50	1.10
52.15	11.61	9.61		
219.40	25.59	20.37		
205.78	55.66	14.85		
85.19	51.38	25.40	7.70	12.17
84.90	10.96	3.26		
19.93	4.25	3.18	0.47	0.44
28.74	11.36	12.42		
66.77	83.20	83.80	30.00	12.00
72.80	5.73	5.17		
224.33	13.96	8.70		
28.66	25.90	26.55	12.70	15.31
143.06	58.39	32.67	4.79	4.23
62.34	42.63	12.80	8.91	5.34
32.61	6.18	4.89		
43.78	19.79	13.23		
136.40	7.63	5.54		
20.52	7.33	3.83		
164.41	14.19	7.43	0.08	0.05
46.80	4.95	4.83		
89.30	23.10	1.13		
235.17	8.87	14.16	5.86	0.77
115.11	17.85	15.77	0.45	0.76
77.97	9.99	9.91		
67.45	22.30	7.52		

Appendix J – Vin Y Raw Numbers (Cont.)

#	YEAR	MILEAGE	HC					CO				
			TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
32	1985	160,384	8.02	7.83	7.64	2.21	1.57	92.78	56.48	45.90	16.00	14.87
33	1985	81,621	4.70	2.05	1.64	1.88	0.23	52.90	9.58	7.72	11.01	0.85
34	1987	NA	2.37	3.32	1.07	0.96	0.62	11.97	15.02	5.12	5.26	2.32
35	1987	77,773	8.74	2.47	1.27			203.23	20.62	7.70		
36	1989	70,101	2.50	3.08	1.69	0.60	0.55	14.91	12.25	8.63	4.35	4.97
37	1987	53,103	1.62	2.67	0.82			30.06	18.80	4.55		
38	1985	89,970	3.27	1.63	1.07	1.47	1.35	28.18	42.05	23.49	27.17	24.75
39	1987	99,311	3.36	3.94	3.01	0.49	0.32	19.62	28.64	16.80	0.70	1.66
40	1987	148,650	2.70	0.48	0.30			12.40	1.72	1.37		
41	1987	50,170	3.41	2.31	1.43	0.60	0.37	23.47	12.62	8.14	4.04	2.18
42	1985	66,048	3.42	1.98	1.54	0.81	0.82	48.57	12.22	10.46	6.29	10.92
43	1987	147,400	2.55	1.99	1.98	0.57	0.43	33.65	8.33	8.17	3.58	0.70
44	1985	227,000	3.09	2.67	2.04			19.82	36.01	27.27		
45	1985	142,000	4.82	1.07	1.15			70.21	6.95	17.06		
46	1987	119,000	1.37	0.58	0.33			44.71	1.69	3.64		
47	1983	45,395	4.42	3.27	3.53	0.33	0.18	40.59	25.20	23.67	2.39	0.52
48	1983	176,000	1.21	3.48	2.38			36.93	16.12	13.42		
49	1988	118,000	3.17	2.56	1.21	0.52	0.34	19.51	9.07	4.32	1.47	0.78
50	1985	93,665	4.48	0.32	0.18			224.52	2.21	2.34		
51	1989	129,200	3.27	3.20	2.99	0.98	0.83	30.88	22.19	18.04	3.76	3.21
52	1981	119,530	5.71	3.52	3.34	0.67	0.42	25.60	34.27	31.09	0.74	1.42
53	1985	162,000	6.20	4.89	2.20	1.11	0.98	39.00	19.40	9.04	1.72	2.26
54	1984	NA	3.99	2.36	2.18			88.51	55.45	46.10		
55	1988	155,657	3.22	5.00	4.11	2.91	0.67	26.57	18.77	14.62	46.29	0.54
56	1989	81,039	3.37	1.62	1.41	0.54	0.37	20.63	5.31	3.22	0.19	0.14
57	1986	91,478	10.19	3.16	1.57			17.58	7.30	3.02		
58	1984	46,433	13.07	1.72	0.68			337.35	9.93	7.14		
59	1984	115,000	3.40	1.86	1.38			31.71	10.68	7.67		
60	1985	63,671	2.77	1.95	1.47			25.23	9.51	6.95		
61	1987	114,780	0.95	1.96	2.10	0.50	0.45	20.85	47.20	21.12	2.42	4.36
62	1989	75,485	1.55	2.01	0.95	0.68	0.39	34.35	10.81	5.36	1.85	0.41
63	1984	161,275	3.33	1.47	1.41			85.38	17.74	24.67		
64	1985	148,000	24.39	3.46	3.29	1.12	0.78	112.25	19.81	24.95	8.67	3.07
	1985.92	106,093	4.57					71.33				

Appendix J (Cont.)

NOx				
TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
0.51	0.59	1.42		
0.90	1.29	1.00	0.72	0.67
1.93	3.70	5.19		
3.31	4.09	2.91	1.94	1.65
0.17	0.11	0.09		
5.31	1.70	1.72	1.71	1.62
1.02	0.94	1.04	0.71	0.67
1.16	1.67	1.91		
5.90	4.70	3.94		
0.15	0.87	0.15		
0.33	1.01	1.16	0.74	0.70
0.52	2.07	2.53		
1.38	1.07	1.00	0.57	0.39
1.25	1.29	1.37		
1.54	1.30	1.10	1.10	1.30
0.49	0.46	0.42		
0.11	1.88	1.98		
1.73	1.20	0.96	0.41	0.42
1.69	2.96	3.41	0.91	0.67
1.27	2.61	2.96	0.21	0.27
1.63	1.63	1.37		
0.59	0.64	0.70		
1.00	1.51	1.65		
4.26	2.19	1.96		
0.21	2.29	3.25	1.24	0.67
1.09	2.71	1.98		
0.76	1.44	0.32		
0.38	3.98	1.92	1.01	1.24
0.79	2.53	2.58	0.98	0.79
0.29	1.11	0.93		
2.47	4.59	4.66		
0.80	1.19	1.25	0.82	0.72

Sub -total \$	Owner add.	Sales Tax	Total Cost	Cat Cost Total of Portion
\$109.33		\$14.57	\$123.90	
\$450.00	\$209.50	\$40.10	\$699.60	\$179.00
\$275.47		\$16.49	\$291.96	
\$450.00	\$180.76	\$38.49	\$669.25	\$192.00
\$450.00	\$3.45	\$25.39	\$478.84	
\$450.00	\$128.22	\$35.55	\$613.77	\$158.00
\$450.00	\$161.50	\$31.19	\$642.69	\$162.00
\$376.25		\$25.36	\$401.61	
\$450.00	\$37.55	\$29.42	\$516.97	
\$450.00	\$154.34	\$33.40	\$637.74	
\$450.00	\$467.15	\$55.58	\$972.73	\$150.00
\$450.00	\$175.86	\$34.26	\$660.12	
\$358.50		\$20.08	\$378.58	\$176.24
\$263.30		\$16.86	\$280.16	
\$236.10		\$14.09	\$250.19	WARRANTY
\$205.77		\$12.58	\$218.35	
\$450.00	\$48.38	\$31.08	\$529.46	
\$373.35		\$23.02	\$396.37	\$136.00
\$450.00	\$168.75	\$37.82	\$656.57	\$200.00
\$354.50		\$19.49	\$373.99	\$214.00
\$286.50		\$14.61	\$301.11	
\$349.32		\$21.46	\$370.78	
\$170.54		\$10.61	\$181.15	
\$413.93		\$26.35	\$440.28	
\$450.00	\$120.67	\$35.13	\$605.80	\$200.59
\$342.77		\$18.85	\$361.62	
\$396.05		\$20.20	\$416.25	
\$277.65		\$17.66	\$295.31	WARRANTY
\$450.00	\$39.50	\$24.96	\$514.46	\$176.00
\$450.00	\$1.90	\$23.05	\$474.95	
\$450.00	\$31.26	\$30.12	\$511.38	
\$450.00	\$80.20	\$32.86	\$563.06	\$145.86

Appendix J (Cont.)

NOx				
TEST 1	TEST 2	TEST 3	TEST 4	TEST 5
5.40	5.64	5.11	5.07	1.74
1.33	1.07	1.19	1.06	0.89
0.18	2.76	2.10		
1.57	6.12	3.41	1.58	0.72
0.99	1.06	0.93		
0.77	0.45	0.57	0.40	0.01
3.95	4.54	4.97	3.00	2.71
6.65	0.24	0.16		
2.08	1.94	1.50	0.66	0.57
3.09	4.67	4.52	2.63	2.35
1.63	1.77	1.88	1.04	1.24
2.26	1.73	1.89		
1.68	3.04	2.40		
2.08	4.36	3.54		
5.75	4.87	4.95	1.80	1.95
0.98	4.89	4.92		
2.91	4.23	3.56	0.99	1.88
0.44	3.46	2.06		
5.53	7.74	7.47	1.65	1.54
0.95	2.22	2.13	1.41	1.39
6.00	5.34	4.24	1.36	0.73
3.91	3.02	3.11		
8.39	1.25	1.07	0.80	0.64
5.20	4.35	4.74	2.78	2.54
1.19	1.76	1.40		
0.32	4.31	3.61		
2.74	1.58	1.82		
3.18	1.06	1.01		
2.39	2.79	4.52	4.12	2.92
2.94	5.98	4.74	2.43	1.12
2.38	4.51	3.26		
2.11	0.31	0.05	0.35	0.36
2.12				

Sub -total \$	Owner add.	Sales Tax	Total Cost	Cat Cost Total of Portion
\$450.00	\$67.75	\$26.41	\$544.16	\$176.00
\$431.81		\$27.35	\$459.16	\$148.07
\$450.00	\$217.99	\$40.58	\$708.57	
\$434.50		\$22.16	\$456.66	\$226.00
\$219.27		\$14.40	\$233.67	
\$303.95		\$15.50	\$319.45	\$186.00
\$450.00	\$147.70	\$30.48	\$628.18	\$186.00
\$450.00	\$116.04	\$35.93	\$601.97	
\$356.70		\$18.19	\$374.89	\$181.00
\$440.20		\$22.96	\$463.16	\$176.00
\$450.00	\$30.64	\$31.14	\$511.78	\$148.00
\$450.00	\$26.96	\$29.88	\$506.84	
\$450.00	\$207.73	\$40.00	\$697.73	
\$450.00	\$113.05	\$34.70	\$597.75	
\$450.00	\$74.10	\$32.52	\$556.62	138.95
\$450.00	\$158.30	\$37.24	\$645.54	
\$450.00	\$18.97	\$29.43	\$498.40	\$205.59
\$333.30		\$17.00	\$350.30	
\$450.00	\$2.68	\$28.52	\$481.20	\$140.00
\$450.00	\$478.79	\$51.08	\$979.87	\$165.00
\$450.00	\$73.45	\$32.49	\$555.94	\$126.00
\$450.00	\$142.01	\$37.38	\$629.39	
\$450.00	\$65.07	\$32.02	\$547.09	\$200.59
\$409.35		\$25.93	\$435.28	\$210.59
\$105.00		\$5.88	\$110.88	
\$450.00	\$411.04	\$48.22	\$909.26	
\$213.80		\$13.98	\$227.78	
\$336.81		\$21.87	\$358.68	
\$450.00	\$25.52	\$30.63	\$506.15	\$121.82
\$450.00	\$53.97	\$32.23	\$536.20	\$210.59
\$450.00	\$50.56	\$32.04	\$532.60	
\$443.94		\$28.03	\$471.97	WARRANTY
			\$488.53	

Appendix K

Wisconsin DNR In-depth Analysis of Emissions Data

This analysis presents information on passing rates, emission reductions from repairs, and effects of preconditioning. It then presents conclusions from this information. The tables in this analysis present information separately for the 64 VIN “Y” vehicles, 16 of the 17 VIN “H” vehicles (one outlier excluded), and the combined sample of 80 vehicles (again, the VIN “H” outlier excluded). This analysis contains three sets of three tables (Table 1a through Table 3c). Tables with an “a” suffix pertain to VIN “Y”; tables with a “b” suffix pertain to VIN “H”; and tables with a “c” suffix pertain to the combined sample. In addition this analysis contains 9 charts which graphically display some of the key comparisons presented in the tables.

Excluded Outlier

The excluded outlier is a 1988 model year VIN “H” vehicle (#17). This vehicle is the only vehicle in the study without emission readings recorded after initial repairs but before any catalyst replacement. Also, the recorded after-catalyst-replacement emission readings suggest an invalid test or a data coding error: the readings before preconditioning are extremely low and the readings after preconditioning are about 20 to 180 times greater than the before-preconditioning readings.

One possible explanation for the sharp increase after preconditioning is an over-heated catalyst. However, the very low readings before preconditioning (0.0027 grams/mile for HC and 0.0212 grams/mile for NO_x) do not seem to reflect a valid test.

Passing Rates

Tables 1a-1c present the passing rates for the vehicles tested in this study for each of the four IM240 tests conducted after repairs. These four tests are:

1. No catalyst replacement; no preconditioning
2. No catalyst replacement with preconditioning
3. Catalyst replacement; no preconditioning
4. Catalyst replacement with preconditioning

These tables present passing rates, with and without NO_x pass/fail considered, for the following three sets of cutpoints:

1. **Phase-in cutpoints** (HC = 2.0 gpm, CO = 60 gpm (<1983)/30 gpm (1983+), and NO_x = 3.0 gpm). Wisconsin's inspection and maintenance (I/M) program has been using these cutpoints for model year 1981-1986 passenger cars since December 1, 1996. Between December 1, 1996, and December 31, 1997, these cutpoints were also used for model year 1987-1990 passenger cars.
2. **Intermediate cutpoints** (HC = 1.3 gpm, CO = 20 gpm, and NO_x = 2.5 gpm). Wisconsin's I/M program had planned to use these cutpoints for 1983-1986 passenger cars starting December 1, 1999. (Cutpoints slightly more lenient than the intermediate cutpoints were also planned for 1981-1982 passenger cars starting December 1, 1999.) However, the Wisconsin Department of Natural Resources has subsequently revised its regulations to keep the phase-in cutpoints indefinitely in effect for model year 1981-1986 passenger cars.
3. **Final cutpoints** (HC = 0.8 gpm, CO = 15 gpm, and NO_x = 2.0 gpm). Wisconsin's I/M program has been using these cutpoints for model year 1991-1996 passenger cars since January 1, 1998, and for 1987-1990 passenger cars since December 1, 1998.

It should be noted that although Wisconsin's I/M program measures IM240 emission for HC, CO, and NO_x, vehicles are not failed for high NO_x because the U.S. Environmental Protection Agency has granted the Lake Michigan region a waiver from certain NO_x control requirements (including I/M pass/fail). Therefore, the NO_x emission measurement has always been only advisory in Wisconsin's enhanced I/M program. NO_x pass/fail may be required in the future, however, to address ozone transport problems.

Tables 1a-1c include separate sub-tables for model years 1981-1986 and model years 1987-1990, since these two groups are currently subject to different sets of cutpoints (maximum allowable emissions) in Wisconsin's I/M program. The final sub-table, which covers all model years (1981-1989), includes passing rates at the I/M program's current cutpoints (a combination of the phase-in and final cutpoints) in addition to the three above-mentioned sets of cutpoints.

Emission Reductions from Repairs

Tables 2a-2c present data pertaining to emission reductions from repairs. It includes:

1. Average IM240 emissions for each of the four tests conducted in the study (labeled as “Test2” to “Test5”, respectively) as well as average IM240 emissions for the I/M test failure that immediately preceded the vehicle’s recruitment into this study (labeled as “Test1”).
2. The average IM240 emission reduction from the pre-recruitment I/M failure (i.e., “Test1”) for each of the four IM240 tests conducted in the study. These emission reductions are presented in both absolute (gpm) and relative (percent) terms.

As in Tables 1a-1c, separate statistics are presented for model years 1981-1986, model years 1987-1989, and model years 1981-1989 (all model years). Also, a separate sub-table includes only those vehicles that had the catalyst replaced (37 of the 80 vehicles).

To determine a best estimate of the IM240 emission reductions from repairs, one would need to know whether each of the pre-recruitment IM240 readings was from a first test (i.e., no preconditioning) or from a second chance test (i.e., with preconditioning). Since this information is not known, one can use a range to estimate the emission reduction, with the endpoints of the range consisting of: (1) the emission reduction achieved from the non-preconditioned test and (2) the emission reduction achieved from the preconditioned test. For example, in Table 2a, for the 34 model year 1981-1986 VIN “Y” vehicles, one can assume that the average HC IM240 emission reduction after all repairs except catalyst replacement is between 3.13 and 3.70 gpm (or between 57% and 68%).

Effects of Preconditioning

Tables 3a-3c include data pertaining to the effects of preconditioning. Their format and data are similar to Tables 2a-2c; the only major difference being that the emission reductions presented are those from the IM240 test without preconditioning to the immediately following preconditioned IM240 test.

Conclusions from Emissions Data

The following conclusions follow from the tables and charts presented in this analysis:

VIN “Y” vs. VIN “H”

The VIN “Y” and VIN “H” vehicles show generally similar performance and patterns in terms of initial emissions levels, emission reductions from repairs, and effects of preconditioning. Caution should be exercised in stating differences between these two VIN classes based on moderate differences in these data because the sample size for the VIN “H” vehicles is quite small. This is especially true for the subset of VIN “H” vehicles that had catalyst replaced (only 5 vehicles: 3 for model years 1981-1986 and 2 for model years 1987-1989). Given this disclaimer, the data suggest, but do not substantiate, the following differences between VIN “Y” and VIN “H” vehicles:

1. The results suggest that the effectiveness of repairs is somewhat better for VIN “H” vehicles than for VIN “Y” vehicles. See Charts 1-9 for a visual comparison.
2. The results suggest that the preconditioning effect is stronger for VIN “Y” vehicles than for VIN “H” vehicles. That is, the drop in emissions after preconditioning is larger for VIN “Y” vehicles than for VIN “H” vehicles. See Charts 4-9 for a visual comparison.

VIN “Y” and VIN “H” Combined

The following conclusions apply to both VIN “Y” and VIN “H” vehicles. The percentages cited in these conclusions are those for the combined sample of VIN “Y” and VIN “H” vehicles (80 vehicles, the one outlier excluded):

1. Replacing the catalytic converter, after completion of the other repairs, is needed to achieve a high retest pass rate. Prior to catalyst replacement, no more than one-half of the vehicles pass the IM240 test at the I/M program’s current cutpoints. After catalyst replacement, the IM240 pass rates are 95% without NOx pass/fail and 86% with NOx pass/fail.

2. Nevertheless, significant HC and CO reductions can be achieved prior to catalyst replacement (53% to 64% reduction for HC and 73% to 79% reduction for CO). However, replacing the catalyst leads to even larger reductions (83% to 89% for HC and 88% to 93% for CO) and often is needed to enable the vehicle to pass.
3. For NO_x, however, the repairs prior to catalyst replacement **increase** NO_x emissions (8% to 19% increase). Replacing the catalyst then leads to significant NO_x reductions (48% to 58%), although these reductions are not as large as those for HC and CO.
4. Implementing pass/fail for NO_x using the current NO_x cutpoints will likely decrease the retest pass rate for the VIN “Y” and VIN “H” vehicles, perhaps by about 10 percentage points. To avoid this decrease, a phase-in of NO_x cutpoints for older vehicles may be needed.
5. At the I/M program’s current cutpoints, a smaller percentage of 1987-1989 model year vehicles pass after repairs than 1981-1986 model year vehicles. All of the 1981-1986 vehicles pass for HC, CO, and NO_x after catalyst replacement and preconditioning. However, 9% of the 1987-1989 vehicles fail for HC and/or CO after catalyst replacement and preconditioning. When NO_x pass/fail is added, this fail rate increases to 23%. This finding underscores the importance of the Wisconsin I/M program’s continuing effort to investigate and develop effective repair strategies for older vehicles. Additional focus may need to be directed to the 1987-1989 model year vehicles.
6. Preconditioning the vehicle significantly lowers the IM240 emission reading. The percent reduction from preconditioning is larger for HC and CO than for NO_x. It is important for Wisconsin’s I/M program to continue its policy of second chance testing to avoid false failures resulting from a lack of preconditioning.

Table 1a
Oldsmobile 307 “VIN Y” Engines
Passing Rates

Model Years 1981-1986

		% Pass Phase-in Cutpoints		% Pass Intermediate Cutpoints		% Pass Final Cutpoints	
		HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx
		HC=2.0 CO=60/30 NOx=3.0		HC=1.3 CO=20 NOx=2.5		HC=0.8 CO=15 NOx=2.0	
<i>Action After Initial Failure</i>	Number Of Vehicles	HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx
No Catalyst Replacement No Preconditioning	34	50%	35%	15%	9%	3%	0%
No Catalyst Replacement With Preconditioning	34	68%	53%	38%	32%	15%	9%
Catalyst replaced No preconditioning	12	92%	83%	67%	58%	42%	42%
Catalyst replaced With Preconditioning	12	100%	100%	83%	83%	58%	58%

Oldsmobile 307 “VIN Y” Engines
Passing Rates

Model Years 1987-1989

		% Pass Phase-in Cutpoints		% Pass Intermediate Cutpoints		% Pass Final Cutpoints	
		HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx
		HC=2.0 CO=60/30 NOx=3.0		HC=1.3 CO=20 NOx=2.5		HC=0.8 CO=15 NOx=2.0	
<i>Action After Initial Failure</i>	Number Of Vehicles	HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx
No Catalyst Replacement No Preconditioning	30	37%	27%	23%	17%	13%	10%
No Catalyst Replacement With Preconditioning	30	67%	47%	47%	30%	20%	13%
Catalyst replaced No preconditioning	20	90%	80%	90%	75%	75%	55%
Catalyst replaced With Preconditioning	20	100%	100%	95%	80%	90%	75%

Table 1a (Cont.)

**Oldsmobile 307 "VIN Y" Engines
Passing Rates**

Model Years 1981-1989

		% Pass Phase-in Cutpoints HC=2.0 CO=60/30 NOx=3.0		% Pass Intermediate Cutpoints HC=1.3 CO=20 NOx=2.5		% Pass Final Cutpoints HC=0.8 CO=15 NOx=2.0	
		HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx
<i>Action After Initial Failure</i>	Number Of Vehicles						
No Catalyst Replacement No Preconditioning	64	44%	31%	19%	12%	8%	5%
No Catalyst Replacement With Preconditioning	64	67%	50%	42%	31%	17%	11%
Catalyst replaced No preconditioning	32	91%	81%	81%	69%	62%	50%
Catalyst replaced With Preconditioning	32	100%	100%	91%	81%	78%	69%

**Oldsmobile 307 "VIN Y" Engines
Passing Rates**

Model Years 1981-1989 (cont.)

		% Pass Current Cutpoints HC=2.0/0.8 CO=60/30/15 NOx=3.0/2.0	
		HC+CO	HC, CO & NOx
<i>Action After Initial Failure</i>	Number Of Vehicles		
No Catalyst Replacement No Preconditioning	64	33%	23%
No Catalyst Replacement With Preconditioning	64	45%	34%
Catalyst replaced No preconditioning	32	81%	66%
Catalyst replaced With Preconditioning	32	94%	84%

Note: The current cutpoints are the "Phase-In" cutpoints for model year 1981-1986 cars and the "Final" cutpoints for model year 1987-1989 cars.

Table 1b (Cont.)

**Chevrolet 305 "VIN H" Engines
Passing Rates**

Model Years 1981-1989

		% Pass Phase-in Cutpoints HC=2.0 CO=60/30 NOx=3.0		% Pass Intermediate Cutpoints HC=1.3 CO=20 NOx=2.5		% Pass Final Cutpoints HC=0.8 CO=15 NOx=2.0	
		HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx	HC+CO	HC, CO & NOx
<i>Action After Initial Failure</i>	Number Of Vehicles						
No Catalyst Replacement No Preconditioning	16	75%	44%	38%	31%	38%	25%
No Catalyst Replacement With Preconditioning	16	81%	62%	50%	38%	31%	19%
Catalyst replaced No preconditioning	5	100%	100%	100%	100%	80%	60%
Catalyst replaced With Preconditioning	5	100%	100%	100%	100%	100%	80%

**Chevrolet 305 "VIN H" Engines
Passing Rates**

Model Years 1981-1989 (cont.)

		% Pass Current Cutpoints HC=2.0/0.8 CO=60/30/15 NOx=3.0/2.0	
		HC+CO	HC, CO & NOx
<i>Action After Initial Failure</i>	Number Of Vehicles		
No Catalyst Replacement No Preconditioning	16	69%	31%
No Catalyst Replacement With Preconditioning	16	69%	44%
Catalyst replaced No preconditioning	5	100%	100%
Catalyst replaced With Preconditioning	5	100%	100%

Note: The current cutpoints are the "Phase-In" cutpoints for model year 1981-1986 cars and the "Final" cutpoints for model year 1987-1989 cars.

Table 1c
“VIN Y” and “VIN H” Engines
Passing Rates

Model Years 1981-1986

		% Pass Phase-in Cutpoints HC=2.0 CO=60/30 NO _x =3.0		% Pass Intermediate Cutpoints HC=1.3 CO=20 NO _x =2.5		% Pass Final Cutpoints HC=0.8 CO=15 NO _x =2.0	
		HC+CO	HC, CO & NO _x	HC+CO	HC, CO & NO _x	HC+CO	HC, CO & NO _x
<i>Action After Initial Failure</i>	Number Of Vehicles						
No Catalyst Replacement No Preconditioning	45	56%	36%	18%	13%	9%	7%
No Catalyst Replacement With Preconditioning	45	69%	53%	38%	31%	16%	11%
Catalyst replaced No preconditioning	15	93%	87%	73%	67%	47%	40%
Catalyst replaced With Preconditioning	15	100%	100%	87%	87%	67%	60%

Model Years 1987-1989

		% Pass Phase-in Cutpoints HC=2.0 CO=60/30 NO _x =3.0		% Pass Intermediate Cutpoints HC=1.3 CO=20 NO _x =2.5		% Pass Final Cutpoints HC=0.8 CO=15 NO _x =2.0	
		HC+CO	HC, CO & NO _x	HC+CO	HC, CO & NO _x	HC+CO	HC, CO & NO _x
<i>Action After Initial Failure</i>	Number Of Vehicles						
No Catalyst Replacement No Preconditioning	35	43%	31%	29%	20%	20%	11%
No Catalyst Replacement With Preconditioning	35	71%	51%	51%	34%	26%	14%
Catalyst replaced No preconditioning	22	91%	82%	91%	77%	77%	59%
Catalyst replaced With Preconditioning	22	100%	100%	95%	82%	91%	77%

Table 1c (Cont.)

“VIN Y” and “VIN H” Engines
Passing Rates

Model Years 1981-1989

		% Pass Phase-in Cutpoints HC=2.0 CO=60/30 NO _x =3.0		% Pass Intermediate Cutpoints HC=1.3 CO=20 NO _x =2.5		% Pass Final Cutpoints HC=0.8 CO=15 NO _x =2.0	
<i>Action After Initial Failure</i>	Number Of Vehicles	HC+CO	HC, CO & NO _x	HC+CO	HC, CO & NO _x	HC+CO	HC, CO & NO _x
No Catalyst Replacement No Preconditioning	80	50%	34%	22%	16%	14%	9%
No Catalyst Replacement With Preconditioning	80	70%	52%	44%	32%	20%	12%
Catalyst replaced No preconditioning	37	92%	84%	84%	73%	65%	51%
Catalyst replaced With Preconditioning	37	100%	100%	92%	84%	81%	70%

Model Years 1981-1989 (cont.)

		% Pass Current Cutpoints HC=2.0/0.8 CO=60/30/15 NO _x =3.0/2.0	
<i>Action After Initial Failure</i>	Number Of Vehicles	HC+CO	HC, CO & NO _x
No Catalyst Replacement No Preconditioning	80	40%	25%
No Catalyst Replacement With Preconditioning	80	50%	36%
Catalyst replaced No preconditioning	37	84%	70%
Catalyst replaced With Preconditioning	37	95%	86%

Note: The current cutpoints are the “Phase-In” cutpoints for model year 1981-1986 cars and the “Final” cutpoints for model year 1987-1989 cars.

Table 2a
Oldsmobile 307 “VIN Y” Engines
Average IM240 Emissions (grams per mile)
and Emission Reductions from Repairs

All “VIN Y” Vehicles

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	34	Average IM240	5.47	2.34	1.77	---	---	83.59	21.53	15.54	---	---	1.96	2.45	2.20	---	---
		Red'n from Test1:															
		Gms/mile		3.13	3.70	---	---		62.05	68.05	---	---		-0.49	-0.24	---	---
		Percent		57%	68%	---	---		74%	81%	---	---		-25%	-12%	---	---
1987 to 1989	30	Average IM240	3.55	2.34	1.67	---	---	57.43	18.60	13.60	---	---	2.31	2.70	2.56	---	---
		Red'n from Test1:															
		Gms/mile		1.21	1.88	---	---		38.83	43.84	---	---		-0.40	-0.26	---	---
		Percent		34%	53%	---	---		68%	76%	---	---		-17%	-11%	---	---
1981 to 1989	64	Average IM240	4.57	2.34	1.72	---	---	71.33	20.16	14.63	---	---	2.12	2.57	2.37	---	---
		Red'n from Test1:															
		Gms/mile		2.23	2.84	---	---		51.17	56.70	---	---		-0.44	-0.25	---	---
		Percent		49%	62%	---	---		72%	79%	---	---		-21%	-12%	---	---

“VIN Y” Vehicles that had Catalyst Replaced

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	12	Average IM240	5.74	3.13	2.64	1.02	0.70	59.76	28.22	21.86	8.03	7.33	2.40	2.53	2.38	1.39	0.99
		Red'n from Test1:															
		Gms/mile		2.61	3.10	4.73	5.04		31.54	37.90	51.73	52.42		-0.14	0.02	1.01	1.41
		Percent		45%	54%	82%	88%		53%	63%	87%	88%		-6%	1%	42%	59%
1987 to 1989	20	Average IM240	3.69	2.94	2.12	0.82	0.52	50.79	23.06	16.82	6.77	2.41	2.70	3.15	2.92	1.48	1.26
		Red'n from Test1:															
		Gms/mile		0.74	1.57	2.87	3.17		27.74	33.98	44.03	48.38		-0.46	-0.22	1.22	1.43
		Percent		20%	42%	78%	86%		55%	67%	87%	95%		-17%	-8%	45%	53%
1981 to 1989	32	Average IM240	4.46	3.01	2.32	0.89	0.58	54.16	24.99	18.71	7.24	4.26	2.58	2.92	2.72	1.44	1.16
		Red'n from Test1:															
		Gms/mile		1.44	2.14	3.56	3.87		29.16	35.45	46.91	49.90		-0.34	-0.13	1.14	1.42
		Percent		32%	48%	80%	87%		54%	65%	87%	92%		-13%	-5%	44%	55%

Test1: Most recent IM240 test prior to vehicle's recruitment into study
 Test2: After repairs; Catalyst not replaced and no preconditioning
 Test3: After repairs; Catalyst not replaced and preconditioning
 Test4: After repairs; Catalyst replaced and no preconditioning
 Test5: After repairs; Catalyst replaced and preconditioning

Table 2b
Chevrolet 305 “VIN H” Engines
Average IM240 Emissions (grams per mile)
and Emission Reductions from Repairs
All “VIN H” Vehicles

Model Years	No. Vehs		HC					CO					NOx					
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	
1981 to 1986	11	Average IM240	5.81	1.60	1.51	---	---	71.61	14.46	15.59	---	---	2.49	2.81	2.47	---	---	
		Red'n from Test1:																
		Gms/mile		4.21	4.30	---	---		57.15	56.03	---	---		-0.33	0.01	---	---	
		Percent		72%	74%	---	---		80%	78%	---	---		-13%	1%	---	---	
1987 to 1989	5	Average IM240	2.31	1.03	0.87	---	---	21.73	6.19	5.51	---	---	2.58	2.73	2.41	---	---	
		Red'n from Test1:																
		Gms/mile		1.28	1.44	---	---		15.53	16.21	---	---		-0.15	0.17	---	---	
		Percent		55%	62%	---	---		71%	75%	---	---		-6%	7%	---	---	
1981 to 1989	16	Average IM240	4.72	1.42	1.31	---	---	56.02	11.88	12.44	---	---	2.52	2.79	2.45	---	---	
		Red'n from Test1:																
		Gms/mile		3.29	3.41	---	---		44.14	43.59	---	---		-0.27	0.06	---	---	
		Percent		70%	72%	---	---		79%	78%	---	---		-11%	2%	---	---	

“VIN H” Vehicles that had Catalyst Replaced

Model Years	No. Vehs		HC					CO					NOx					
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	
1981 to 1986	3	Average IM240	10.03	2.48	2.34	0.46	0.24	66.34	18.14	17.67	2.10	1.30	3.79	4.19	3.50	1.34	1.00	
		Red'n from Test1:																
		Gms/mile		7.55	7.69	9.58	9.80		48.20	48.67	64.24	65.04		-0.40	0.29	2.45	2.79	
		Percent		75%	77%	95%	98%		73%	73%	97%	98%		-11%	8%	65%	74%	
1987 to 1989	2	Average IM240	3.18	1.86	1.58	0.31	0.23	34.92	12.63	11.02	0.44	0.22	3.59	3.34	3.40	1.28	1.18	
		Red'n from Test1:																
		Gms/mile		1.32	1.60	2.87	2.95		22.30	23.90	34.49	34.71		0.26	0.20	2.31	2.41	
		Percent		42%	50%	90%	93%		64%	68%	99%	99%		7%	5%	64%	67%	
1981 to 1989	5	Average IM240	7.29	2.23	2.04	0.40	0.23	53.77	15.93	15.01	1.43	0.87	3.71	3.85	3.46	1.32	1.07	
		Red'n from Test1:																
		Gms/mile		5.06	5.25	6.89	7.06		37.84	38.76	52.34	52.91		-0.14	0.25	2.39	2.64	
		Percent		69%	72%	95%	97%		70%	72%	97%	98%		-4%	7%	64%	71%	

Test1: Most recent IM240 test prior to vehicle's recruitment into study
 Test2: After repairs; Catalyst not replaced and no preconditioning
 Test3: After repairs; Catalyst not replaced and preconditioning
 Test4: After repairs; Catalyst replaced and no preconditioning
 Test5: After repairs; Catalyst replaced and preconditioning

Table 2c
“VIN Y” and “VIN H” Engines
Average IM240 Emissions (grams per mile)
and Emission Reductions from Repairs

All Vehicles

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	45	Average IM240	5.55	2.16	1.70	---	---	80.66	19.80	15.55	---	---	2.09	2.54	2.27	---	---
		Red'n from Test1:															
		Gms/mile		3.39	3.84	---	---	60.86	65.11	---	---		-0.45	-0.18	---	---	
Percent		61%	69%	---	---	75%	81%	---	---		-21%	-8%	---	---			
1987 to 1989	35	Average IM240	3.37	2.15	1.56	---	---	52.33	16.83	12.44	---	---	2.35	2.71	2.54	---	---
		Red'n from Test1:															
		Gms/mile		1.22	1.81	---	---	35.50	39.89	---	---		-0.36	-0.20	---	---	
Percent		36%	54%	---	---	68%	76%	---	---		-15%	-8%	---	---			
1981 to 1989	80	Average IM240	4.60	2.16	1.64	---	---	68.27	18.50	14.19	---	---	2.20	2.61	2.39	---	---
		Red'n from Test1:															
		Gms/mile		2.44	2.96	---	---	49.76	54.08	---	---		-0.41	-0.18	---	---	
Percent		53%	64%	---	---	73%	79%	---	---		-19%	-8%	---	---			

Vehicles that had Catalyst Replaced

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	15	Average IM240	6.60	3.00	2.58	0.90	0.61	61.07	26.20	21.02	6.84	6.13	2.67	2.86	2.60	1.38	0.99
		Red'n from Test1:															
		Gms/mile		3.60	4.02	5.70	5.99	34.87	40.05	54.23	54.95		-0.19	0.07	1.29	1.69	
Percent		55%	61%	86%	91%	57%	66%	89%	90%		-7%	3%	48%	63%			
1987 to 1989	22	Average IM240	3.64	2.84	2.07	0.77	0.49	49.35	22.11	16.29	6.19	2.21	2.78	3.17	2.96	1.46	1.26
		Red'n from Test1:															
		Gms/mile		0.80	1.57	2.87	3.15	27.24	33.06	43.16	47.14		-0.39	-0.18	1.32	1.52	
Percent		22%	43%	79%	87%	55%	67%	87%	96%		-14%	-7%	47%	55%			
1981 to 1989	37	Average IM240	4.84	2.91	2.28	0.83	0.54	54.10	23.77	18.21	6.46	3.80	2.74	3.05	2.82	1.43	1.15
		Red'n from Test1:															
		Gms/mile		1.93	2.56	4.01	4.30	30.33	35.89	47.65	50.30		-0.31	-0.08	1.31	1.59	
Percent		40%	53%	83%	89%	56%	66%	88%	93%		-11%	-3%	48%	58%			

Test1: Most recent IM240 test prior to vehicle's recruitment into study
 Test2: After repairs; Catalyst not replaced and no preconditioning
 Test3: After repairs; Catalyst not replaced and preconditioning
 Test4: After repairs; Catalyst replaced and no preconditioning
 Test5: After repairs; Catalyst replaced and preconditioning

Table 3a
Oldsmobile 307 “VIN Y” Engines
Average IM240 Emissions (grams per mile)
and Emission Reductions from Preconditioning
All “VIN Y” Vehicles

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	34	Average IM240	5.47	2.34	1.77	---	---	83.59	21.53	15.54	---	---	1.96	2.45	2.20	---	---
		Red'n from Precond.:															
		Gms/mile		---	0.57	---	---		---	6.00	---	---		---	0.25	---	---
Percent		---	24%	---	---		---	28%	---	---		---	10%	---	---		
1987 to 1989	30	Average IM240	3.55	2.34	1.67	---	---	57.43	18.60	13.60	---	---	2.31	2.70	2.56	---	---
		Red'n from Precond.:															
		Gms/mile		---	0.67	---	---		---	5.00	---	---		---	0.14	---	---
Percent		---	28%	---	---		---	27%	---	---		---	5%	---	---		
1981 to 1989	64	Average IM240	4.57	2.34	1.72	---	---	71.33	20.16	14.63	---	---	2.12	2.57	2.37	---	---
		Red'n from Precond.:															
		Gms/mile		---	0.61	---	---		---	5.53	---	---		---	0.20	---	---
Percent		---	26%	---	---		---	27%	---	---		---	8%	---	---		

“VIN Y” Vehicles that had Catalyst Replaced

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	12	Average IM240	5.74	3.13	2.64	1.02	0.70	59.76	28.22	21.86	8.03	7.33	2.40	2.53	2.38	1.39	0.99
		Red'n from Precond.:															
		Gms/mile		---	0.49	---	0.32		---	6.36	---	0.70		---	0.15	---	0.40
Percent		---	16%	---	31%		---	23%	---	9%		---	6%	---	29%		
1987 to 1989	20	Average IM240	3.69	2.94	2.12	0.82	0.52	50.79	23.06	16.82	6.77	2.41	2.70	3.15	2.92	1.48	1.26
		Red'n from Precond.:															
		Gms/mile		---	0.82	---	0.30		---	6.24	---	4.36		---	0.24	---	0.21
Percent		---	28%	---	37%		---	27%	---	64%		---	8%	---	14%		
1981 to 1989	32	Average IM240	4.46	3.01	2.32	0.89	0.58	54.16	24.99	18.71	7.24	4.26	2.58	2.92	2.72	1.44	1.16
		Red'n from Precond.:															
		Gms/mile		---	0.70	---	0.31		---	6.29	---	2.98		---	0.21	---	0.29
Percent		---	23%	---	35%		---	25%	---	41%		---	7%	---	20%		

Test1: Most recent IM240 test prior to vehicle's recruitment into study
 Test2: After repairs; Catalyst not replaced and no preconditioning
 Test3: After repairs; Catalyst not replaced and preconditioning
 Test4: After repairs; Catalyst replaced and no preconditioning
 Test5: After repairs; Catalyst replaced and preconditioning

Table 3b
Chevrolet 305 “VIN H” Engines
Average IM240 Emissions (grams per mile)
and Emission Reductions from Preconditioning
All “VIN H” Vehicles

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	11	Average IM240	5.81	1.60	1.51	---	---	71.61	14.46	15.59	---	---	2.49	2.81	2.47	---	---
		Red'n from Precond.:															
		Gms/mile		---	0.09	---	---		---	-1.12	---	---		---	0.34	---	---
Percent		---	6%	---	---		---	-8%	---	---		---	12%	---	---		
1987 to 1989	5	Average IM240	2.31	1.03	0.87	---	---	21.73	6.19	5.51	---	---	2.58	2.73	2.41	---	---
		Red'n from Precond.:															
		Gms/mile		---	0.16	---	---		---	0.68	---	---		---	0.32	---	---
Percent		---	15%	---	---		---	11%	---	---		---	12%	---	---		
1981 to 1989	16	Average IM240	4.72	1.42	1.31	---	---	56.02	11.88	12.44	---	---	2.52	2.79	2.45	---	---
		Red'n from Precond.:															
		Gms/mile		---	0.11	---	---		---	-0.56	---	---		---	0.33	---	---
Percent		---	8%	---	---		---	-5%	---	---		---	12%	---	---		

“VIN H” Vehicles that had Catalyst Replaced

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	3	Average IM240	10.03	2.48	2.34	0.46	0.24	66.34	18.14	17.67	2.10	1.30	3.79	4.19	3.50	1.34	1.00
		Red'n from Precond.:															
		Gms/mile		---	0.14	---	0.22		---	0.46	---	0.80		---	0.69	---	0.35
Percent		---	6%	---	48%		---	3%	---	38%		---	17%	---	26%		
1987 to 1989	2	Average IM240	3.18	1.86	1.58	0.31	0.23	34.92	12.63	11.02	0.44	0.22	3.59	3.34	3.40	1.28	1.18
		Red'n from Precond.:															
		Gms/mile		---	0.28	---	0.09		---	1.61	---	0.22		---	-0.06	---	0.10
Percent		---	15%	---	27%		---	13%	---	51%		---	-2%	---	8%		
1981 to 1989	5	Average IM240	7.29	2.23	2.04	0.40	0.23	53.77	15.93	15.01	1.43	0.87	3.71	3.85	3.46	1.32	1.07
		Red'n from Precond.:															
		Gms/mile		---	0.20	---	0.17		---	0.92	---	0.57		---	0.39	---	0.25
Percent		---	9%	---	42%		---	6%	---	40%		---	10%	---	19%		

Test1: Most recent IM240 test prior to vehicle's recruitment into study
 Test2: After repairs; Catalyst not replaced and no preconditioning
 Test3: After repairs; Catalyst not replaced and preconditioning
 Test4: After repairs; Catalyst replaced and no preconditioning
 Test5: After repairs; Catalyst replaced and preconditioning

Table 3c
“VIN Y” and “VIN H” Engines
Average IM240 Emissions (grams per mile)
and Emission Reductions from Preconditioning
All Vehicles

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	45	Average IM240	5.55	2.16	1.70	---	---	80.66	19.80	15.55	---	---	2.09	2.54	2.27	---	---
		Red'n from Precond.:															
		Gms/mile		---	0.45	---	---		---	4.26	---	---		---	0.27	---	---
		Percent		---	21%	---	---		21%	---	---		---	11%	---	---	
1987 to 1989	35	Average IM240	3.37	2.15	1.56	---	---	52.33	16.83	12.44	---	---	2.35	2.71	2.54	---	---
		Red'n from Precond.:															
		Gms/mile		---	0.59	---	---		---	4.39	---	---		---	0.16	---	---
		Percent		---	28%	---	---		26%	---	---		---	6%	---	---	
1981 to 1989	80	Average IM240	4.60	2.16	1.64	---	---	68.27	18.50	14.19	---	---	2.20	2.61	2.39	---	---
		Red'n from Precond.:															
		Gms/mile		---	0.51	---	---		---	4.31	---	---		---	0.23	---	---
		Percent		---	24%	---	---		23%	---	---		---	9%	---	---	

Vehicles that had Catalyst Replaced

Model Years	No. Vehs		HC					CO					NOx				
			Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5	Test1	Test2	Test3	Test4	Test5
1981 to 1986	15	Average IM240	6.60	3.00	2.58	0.90	0.61	61.07	26.20	21.02	6.84	6.13	2.67	2.86	2.60	1.38	0.99
		Red'n from Precond.:															
		Gms/mile		---	0.42	---	0.30		---	5.18	---	0.72		---	0.26	---	0.39
		Percent		---	14%	---	33%		20%	---	10%		---	9%	---	28%	
1987 to 1989	22	Average IM240	3.64	2.84	2.07	0.77	0.49	49.35	22.11	16.29	6.19	2.21	2.78	3.17	2.96	1.46	1.26
		Red'n from Precond.:															
		Gms/mile		---	0.77	---	0.28		---	5.82	---	3.98		---	0.21	---	0.20
		Percent		---	27%	---	37%		26%	---	64%		---	7%	---	14%	
1981 to 1989	37	Average IM240	4.84	2.91	2.28	0.83	0.54	54.10	23.77	18.21	6.46	3.80	2.74	3.05	2.82	1.43	1.15
		Red'n from Precond.:															
		Gms/mile		---	0.63	---	0.29		---	5.56	---	2.66		---	0.23	---	0.28
		Percent		---	22%	---	35%		23%	---	41%		---	8%	---	20%	

Test1: Most recent IM240 test prior to vehicle's recruitment into study
 Test2: After repairs; Catalyst not replaced and no preconditioning
 Test3: After repairs; Catalyst not replaced and preconditioning
 Test4: After repairs; Catalyst replaced and no preconditioning
 Test5: After repairs; Catalyst replaced and preconditioning

NOTES

Glossary of Terms

AIR

Air Injection Reaction. An emission control device designed to pump air to either the exhaust manifold(s), catalytic converter(s), or atmosphere.

ASE

Automotive Service Excellence. A nationally recognized testing organization providing certification for technicians in the automotive industry

Atmospheric Photochemical Process

The atmospheric requirements for ozone formation are sunlight and air. When concentrations of HC in the atmosphere become sufficiently high and NO_x is present in the correct ratio, the action of sunlight causes them to react chemically, forming photochemical ozone. Ozone is the principal ingredient in smog.

Automotive Emissions

Gaseous and particulate compounds that are emitted from a car's exhaust, crankcase, carburetor, fuel tank, etc., including hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NO_x), and carbon dioxide (CO₂).

Blue Book

Emission Repair Facility Report. A guide that helps the vehicle owner locate an emission repair facility by area. The information listed identifies each repair facility by Name, Address, Phone Number and if the facility is Recognized. This report also tells how individual repair facilities are doing in terms of getting cars to pass reinspection on the first trip back to the test station.

Catalytic Converter

An emission control device located in the exhaust system that converts HC, CO, and NO_x into harmless H₂O, CO₂, N₂, and O₂.

CCC

Computer Command Control. The name of General Motors' computer engine control system that uses a carburetor.

Chassis Dynamometer

A device that applies a controlled load to the drive wheels of the vehicle. To correctly simulate the road load for a given vehicle, the dynamometer must be programmed for the correct inertia weight of the vehicle.

Choke

Part of a carburetor that provides enrichment for cold engine operation.

CMAQ

U.S. Congestion Mitigation and Air Quality Improvement Program.

CO

Carbon Monoxide. A gas created when there is not enough oxygen present during combustion. CO is a non-irritating, colorless, odorless toxic gas with increasing concentrations produced under rich air fuel conditions.

CO₂

Carbon Dioxide. A product of the combustion process, and an indicator of engine combustion efficiency.

Combustion

The process of burning.

CTS

Coolant Temperature Sensor. Signals the computer as to the temperature of the engine coolant.

Cutpoint

Maximum amount of emissions a vehicle is allowed to produce in order to pass inspection.

CVS

Constant Volume Sampling. A system that guarantees a constant volume and rate of ambient air and exhaust will pass through the gas analyzer. This allows the measurement of the total pollutants the vehicle emitted during the IM 240 test.

Dwell

The amount of time, recorded on a meter in degrees, that voltage passes through a closed switch.

EGR

Exhaust Gas Recirculation. An emission control device to reduce NO_x.

ECM

Electronic Control Module. The computer on the vehicle

Engine Analyzer

Consists of several pieces of test equipment mounted in one cabinet. Besides an oscilloscope, the analyzer may include a digital multi meter, exhaust gas analyzer, pressure-vacuum gauge, cylinder balance tester, compression tester, cranking balance tester, vacuum pump, and timing light.

EPA

United States Environmental Protection Agency. A federal government agency that oversees the enforcement of laws related to the environment. Included in these laws are regulations on the amount and content of automotive emissions.

4 or 5 Exhaust Gas Analyzer

Draws a sample of the vehicle's exhaust gas from the tailpipe. A 4 gas measures HC, CO, O₂, and CO₂. A 5 gas adds NO_x measurement capabilities. These analyzers use partial stream sampling that draws a low volume of exhaust gases and measures them in concentration or parts per million (ppm) and percentage (%).

FTP

Federal Test Procedure. A test used to determine the compliance of light-duty vehicles and light-duty trucks with federal emissions standards. The test is intended to represent typical driving patterns in primarily urban areas.

Fuel Inlet Restrictor

A restrictor in the fuel filler of the vehicle under the gas cap that will not allow a regular leaded fuel gas pump nozzle to enter. This restrictor is installed on every vehicle that requires unleaded fuel.

GPM

Grams Per Mile. The unit measurement of pollutants used for an IM240 or FTP test.

HC

Hydrocarbon. Gasoline vapor that either did not burn completely in the combustion process or is released from the vehicle through evaporation.

Ignition System

Electrical components and connections that produce and distribute high-voltage electricity to ignite the air-fuel mixture inside the engine.

Ignition Timing

The time when the spark plug is fired in relation to crankshaft degree.

IM240

An IM240 test is a 240 second transient driving cycle during which a motor vehicle is operated on a chassis dynamometer under variable loaded conditions. This style of test most accurately characterizes vehicle exhaust emissions by total volume or mass.

Laboratory Oscilloscope (or Lab Scope)

Displays a line pattern representing voltage in relation to time. It provides detailed information on inputs and outputs of the vehicle's computer.

LDGV

Light Duty Gas Vehicle. Vehicles that are considered passenger cars.

Nonattainment Area

A geographic area in which the level of a criteria air pollutant is higher than the level allowed by the federal standards.

NO_x

Oxides of Nitrogen. A variety of compounds consisting of nitrogen and oxygen. It is formed under engine conditions of high engine temperature, high load, and high engine combustion pressure.

O₂ Sensor

Input sensor for the vehicle computer so that it may fine tune the fuel mixture.

Ozone

Oxygen rich (O₃) gas created when Hydrocarbons (HC) and Oxides of Nitrogen (NO_x) react under sunlight. Ozone is the principal ingredient in smog

Preconditioning

Bringing a vehicle up to operating temperature before it is driven through an IM240 test.

Purge

Part of the evaporative emission system. Allows fuel vapors stored in the charcoal canister to be drawn into a running engine.

Scan Tool

Converts computer pulses or signals directly into a digital or numerical display. This device makes it easier to read electronic trouble codes and other important data.

TAC

Technical Assistance Center. A special free-of-charge diagnostic evaluation center for owners of vehicles that have failed the emission test two or more times. The TAC diagnostic technicians assist motorists with repair strategies for their vehicles.

Technician Training Subcommittee

A group made up of DNR, DOT, Envirotest, repair facility owners, service technician, and instruction personnel that address emission related training issues that effect the repair community.

Thermostatic Air Cleaner

An emission control device located on the air cleaner that provides warm air to the engine during cold engine operation.

TPS

Throttle Position Sensor. Signals the computer as to the position of the throttle.

Vacuum lines

Provides a vacuum path from the source (engine) to a device that functions on vacuum.

Waiver

Allows vehicle registration renewal for a continuing failing vehicle when certain conditions are met.

WISETECH

Wisconsin Emission Technician. A training program offered by technical colleges in southeastern Wisconsin for instruction on enhanced emission inspection (IM240) diagnosis and repair.

WVIP

Wisconsin Vehicle Inspection Program. The name of the Wisconsin emission testing program for vehicle compliance.

VIR

Vehicle Inspection Report. Contains vehicle information and the results of an emission inspection. The reverse side contains repair data to be completed by the person performing the repairs on a failing vehicle.