Literature and Best Practices Scan: Vehicle Inspection and Maintenance (I/M) Programs

Project Number 0092-02-09

Final Report

Submitted to the

Wisconsin Department of Transportation
Bureau of Vehicle Services
Bureau of Environment

Prepared by:

Rob Klausmeier
dKC – de la Torre Klausmeier Consulting, Inc
Austin, TX

June 2002

This research was funded by the Wisconsin Council on Research of the Wisconsin Department of Transportation and the Federal Highway Administration under Project 0092-02-09. The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views of the Wisconsin Department of Transportation or the Federal Highway Administration at the time of publication.

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof. This report does not constitute a standard, specification or regulation.

The United States Government does not endorse products or manufacturers. Trade and manufacturers' names appear in this report only because they are considered essential to the object of the document.

TABLE OF CONTENTS

1.0 INTRODUCTION AND SUMMARY

The state of Wisconsin operates one of the nation's most effective inspection/maintenance (I/M) programs. In Wisconsin's I/M program, vehicles registered in the Milwaukee metropolitan area are subjected to a transient emission test using the IM240 test cycle or an on-board diagnostic (OBDII) check, if the vehicle is a 1996 or newer model. These tests represent the state of art for I/M testing. However, future improvements in motor vehicles and improved fuels will reduce the air quality benefits associated with traditional I/M programs including Wisconsin's. At the same time, new emission test methods may become available. To address the changing needs of Wisconsin's I/M program, the State must determine how upcoming changes in vehicle technology and emission test methods will impact the emission benefits, efficiency and public acceptance of the I/M program.

The Wisconsin Department of Transportation Bureau of Vehicle Services (BVS) contracted de la Torre Klausmeier Consulting (dKC) to prepare a comprehensive planning document on the future of I/M. The goals of this study are:

- Identify and discuss the key issues related to Wisconsin's I/M program;
- Assess the validity of existing information to address these key issues; and
- Assess the need and scope of an expanded study to provide information needed to make proper decisions in the future about Wisconsin's I/M program.

This report presents the findings of the study. The report reviews the following specific research areas related to I/M programs and recommends additional research when appropriate:

- Status of existing I/M programs in the U.S.;
- Status of I/M research being performed by other states;
- Status of current I/M technology, including:
    1. OBDII testing;
    2. Identification of liquid gasoline leakers;
    3. Particulate/diesel emissions control programs;
    4. Remote sensing programs;
    5. Toxic emission control programs
    6. Supplemental federal test procedure (SFTP); and
    7. EPA activities related to I/M programs.

Key Findings

Following are the key findings of this project:

- Wisconsin, along with several other states, continues to violate the 1-hour ozone standard (although Wisconsin's non-attainment areas will likely soon be redesignated as maintenance areas), and the State will likely be designated non-attainment for the new 8-hour standard. I/M will continue to be an important part of current and future ozone control strategies.
- The network design and inspection methods used in Wisconsin also have been successfully used in several other I/M programs. Wisconsin benefits from being able to share experiences of other states with similar I/M programs.
- Wisconsin can benefit by keeping close communication with states with major I/M research plans. The states of California, Arizona, Virginia, and Oregon are performing research or planning to perform research in the following:
    - New types of I/M networks particularly OBD inspection;
    - Low income repair assistance programs (LIRAP);
    - Finding Liquid Leakers and other vehicles with evaporative emission problems;
    - OBDII effectiveness;
    - Remote sensing effectiveness on current model vehicles;
    - Reducing diesel emissions.
- Wisconsin's OBDII program appears to be successful. Wisconsin appears to be failing the expected percentage of vehicles and has not reported difficulty in getting vehicles to comply with OBDII requirements.
- Wisconsin can develop incentives to encourage motorists to respond to illuminated malfunction indicator lamps (MIL) in the absence of an I/M program. Educating motorists about their OBDII systems is a critical step in getting motorists to respond to illuminated MILs. Also, Wisconsin could use alternative inspection networks to perform convenient and inexpensive OBDII tests.
- Identifying and repairing vehicles with liquid leaks or gross evaporative leaks can yield substantial emission reductions. .
- Inspecting diesels in an I/M program is expensive and has minimal benefits. dKC recommends that Wisconsin revisit diesel I/M in the future, after remote sensing and other less obtrusive ways to test diesels are tested and proven.
- Remote sensing does not appear to be a promising option for improving the efficiency of Wisconsin's I/M program, due to concerns over errors of omission (false passes) and errors of commission (false failures).
- I/M programs, reformulated fuels, Low-Emission Vehicle (LEV) standards and other controls implemented for motor vehicles have significantly reduced toxic emissions.

Many states believe that the primary benefits from controlling motor vehicle emissions are from reduced toxic emissions, even though they enacted the programs primarily to reduce ozone levels.

Research Recommendations

The study concludes that additional research is needed to better define future I/M requirements. Following are key research recommendations in order of importance:

1. **MIL Response Study** – Theoretically, I/M programs will not be needed in the future if motorists would respond to illuminated malfunction indicator lamps (MILs). The State should conduct focus groups and survey motorists, technicians, and auto dealers to address the following questions:
   - How do you get motorists to respond to illuminated MILs?
   - Is I/M the only way to keep most vehicles with illuminated MILs from operating?
2. **Evaluate stand-Alone Alternatives to Centralized OBDII Inspection** – Because test equipment is inexpensive, OBDII inspections could be done in a wide variety of scenarios. The State should investigate alternatives to centralized testing of OBDII systems. Research is needed on the cost, enforceability and public acceptance of alternative ways of performing OBD inspections.
3. **Determine how to find vehicles with liquid leaks and other gross evaporative emission problems** – Because of the potential benefits, the State should investigate ways to identify vehicles with liquid leaks and other gross evaporative emission problems. Research is needed to determine how vehicles with gross evaporative or fuel leaks can be identified and repaired most cost-effectively.
4. **Assess the need for Tailpipe Tests on High Mileage OBDII Equipped Vehicles** – Currently, we do not know how difficult it will be to repair high mileage OBDII equipped vehicles that fail inspection. The State should investigate the need for back-up tailpipe I/M tests on high mileage OBDII equipped vehicles. In addition, the State needs to determine if waivers should be issued for high mileage vehicles that fail the OBDII inspection.
5. **Investigations into ways to cheat the OBD inspection** – Some officials have expressed concerns that it's possible to beat the OBDII inspection. Wisconsin should stay in touch with other I/M programs and determine if and when OBD cheater devices are an issue to worry about. Wisconsin should routinely analyze I/M program data to determine if there may be a problem with vehicles that fail with catalyst codes passing retests with the catalyst monitor "not ready".

The first two recommended studies are best performed only in Wisconsin, since they address issues that can vary significantly from state-to-state. The last three studies could be done by pooling resources with other states, since they address largely technical issues.

2.0 STATUS OF U.S. I/M PROGRAMS

2.1 Current Ozone Attainment Status

Most areas with I/M programs implemented them because they had metropolitan areas that exceeded the 1-hour ozone standard. I/M will continue to be an important part of current and future ozone control strategies. Wisconsin, along with several other states continues to need I/M to meet the 1-hour ozone standard. In addition, areas in Wisconsin will likely be designated as non-attainment for the new 8-hour standard. State Implementation Plans (SIPs) for compliance with the 8 hour standard will likely include I/M as a key strategy. Following is a summary of ozone attainment status in different states.

Areas that are Non-Attainment for the 1-hour Ozone standard

39 of the original 98 Ozone Non-Attainment Areas continue to exceed the 1-Hour standard in the 1997-99 period[1]. Areas in the following states that exceeded the 1-Hour standard in 1991 continue to exceed the 1-Hour Ozone standard:

- Alabama
- California
- Connecticut
- Delaware
- District of Columbia
- Georgia
- Illinois (IL-IN-WI Tri-State area)
- Indiana (IL-IN-WI Tri-State area)
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan
- Missouri
- New Jersey
- New York
- North Carolina
- Pennsylvania
- Tennessee
- Texas
- Virginia
- West Virginia
- Wisconsin (IL-IN-WI Tri-State area)

[1] Average number of annual 1-Hour exceedences (>0.12 ppm) is greater than 1.0 over a three-year period.

The Tri-State IL-IN-WI area is included on the above list, but more recent data indicates that the area is in attainment of the 1 Hour Ozone standard. As a result, Wisconsin's non-attainment areas along with adjoining areas in Illinois and Indiana are in the process of being redesignated as maintenance areas. I/M will likely be a key maintenance strategy.

Areas that are projected to be Non-Attainment for the proposed 8-hour Ozone standard

332 counties are projected to exceed the proposed 8-Hour ozone standard[2]. Areas in the following states are projected to exceed the proposed 8-Hour standard (those in **bold** were not on the 1-hour exceedence list):

- Alabama
- **Arizona**
- Arkansas
- California
- Connecticut
- Delaware
- District of Columbia
- **Florida**
- Georgia
- Illinois
- Indiana
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan
- **Mississippi**
- Missouri
- **New Hampshire**
- New Jersey
- New York
- North Carolina
- **Ohio**
- **Oklahoma**
- Pennsylvania

[2] Three-year average of the annual 4th maximum 8-hour daily maximum ozone concentration is greater than 0.08 ppm.

- **Rhode Island**
- **South Carolina**
- Tennessee
- Texas
- Virginia
- West Virginia
- Wisconsin

EPA lists the specific counties that are projected to be Non-Attainment for the 8-hour standard. Generally, a much larger portion of the population is included in the 8-Hour areas than in the 1-Hour areas.

2.2 Current I/M Program Status

Table 1 summarizes the status of U.S. I/M programs. The table shows the type of network (test-only or test-and-repair), program coverage, the test or data collection network provider, whether OBDII inspections will be performed, type of tailpipe test, and coverage of diesels. The network design and test methods used in Wisconsin also have been successfully used in several other I/M programs. Wisconsin benefits from being able to share experiences of other states with similar I/M programs.

Table 1 – Status of Existing I/M Programs

State	Existing Program Features						
	Net-work Type[3]	Current Coverage	Data Network Provider	OBD to be added to current test?	Tailpipe Test TSI (Two Spd Idle), ASM, IM240, BAR31, Other	Diesels covered?	NOx as well as HC and CO tested?
AK	T&R	Fairbanks	none	yes	TSI		
AZ	TO	Phoenix, Tucson	Gordon Darby	yes	IM240 (AZ147)	yes	yes
CA	Hybrid	Statewide	MCI	yes	TSI/ASM		yes
CO	Hybrid	?Front Range?	ESP	yes	TSI/IM240	yes	
CT	TO[4]	Statewide	ESP/AGBAR	yes	ASM		yes
D.C.	TO	areawide	none	yes	IM240		
DE	TO	Statewide	none	yes	TSI		
GA	T&R	Metro Atlanta	MCI	yes	ASM		yes
IL	TO	Metro Chicago	ESP	yes	IM240		
IN	TO	Metro Chicago	ESP	yes	IM240		yes
KY	TO	Louisville	Gordon Darby	yes	Idle		
MA	T&R	Statewide	MCI	yes	BAR31	yes	yes
MD	TO	Metro Balt.	ESP	yes	IM240		
ME	T&R	Metro Portland	none	yes			
MO	Hybrid	Metro St. Louis	ESP	yes	IM240		
NC	T&R	Raleigh, Charlotte	MCI	yes	TSI/none		
NH	T&R	Statewide	none	yes			
NJ	Hybrid	Statewide	MCI	yes	ASM	Yes	yes
NV	T&R	Reno, Las Vegas	MCI	yes	TSI	Yes	
NY	T&R	Upstate to be OBD only	none	yes			
NY	T&R	Metro NY	TESTCOM	yes	IM240		yes
OH	TO	Cleveland, Dayton, Cincinnati	ESP	yes	IM240/TSI	Yes	yes
OR	TO	Metro Portland	none	yes	BAR31		yes
PA	T&R	Metro Phila. & Pittsburgh	MCI	yes	ASM/TSI		yes
RI	T&R	Statewide	Keating	yes	BAR31		yes
TX	T&R	DFW & Houston	MCI	yes	ASM		Yes

[3] TO=Test-Only, T&R=Test-and-Repair, Hybrid=Combination of Test-Only and Test-and-Repair
[4] State just awarded contract to AGBAR for Test-and-Repair I/M program.

State	Existing Program Features						
	Net-work Type[3]	Current Coverage	Data Network Provider	OBD to be added to current test?	Tailpipe Test TSI (Two Spd Idle), ASM, IM240, BAR31, Other	Diesels covered?	NOx as well as HC and CO tested?
UT	T&R	Salt Lake, Weber, Davis and Utah Counties	SLC: AGBAR, Other areas: none	yes	ASM,IM240, TSI	yes	yes
VA	T&R	No. VA	ProtectAir	yes	ASM		yes
VT	T&R	Statewide	none	yes			
WA	TO	Metro Seattle, Spokane	AGBAR	yes	ASM (No NOx)		
WI	TO	Metro Milwaukee	ESP	yes	IM240		yes

2.3 I/M Research Underway by States

Table 2 summarizes I/M planning efforts underway in other states with I/M programs. States are performing research or planning to perform research in the following areas:

- Assessment of network changes - many states are evaluating whether OBDII inspections could be performed in alternative networks;
- Programs to identify gross polluters and/or clean screen likely low emitting vehicles;
- Independent program evaluation tests – programs where vehicles are pulled over for emissions inspection or receive on-road emissions inspection via remote sensing devices;
- Programs to identify liquid gasoline leakers;
- Technician training improvements; and
- Low-income repair systems programs.

Table 2 – Status of I/M Planning

State	Research Underway or Planned					
	Network changes	Clean Screening/ Gross Polluter ID	Independent Program Eval Tests	Identifying Liquid Gasoline Leakers	Technician training	Low income repair assistance programs (LIRAP)
AZ	X	X		X	X	
CA	X	X	X(Road-side pull-overs)	X	X	X
CT	X		X (RSD)		X	
DE		X			X	
GA			X (RSD)		X	
IL			X (RSD)		X	
NJ			X (RSD)		X	
NY			X (RSD)			
NY			X (RSD)			
OR	X		X (RSD)		X	
TX		X	X (RSD)		X	
UT		X			X	
VA		X	X (RSD)		X	
WI					X	

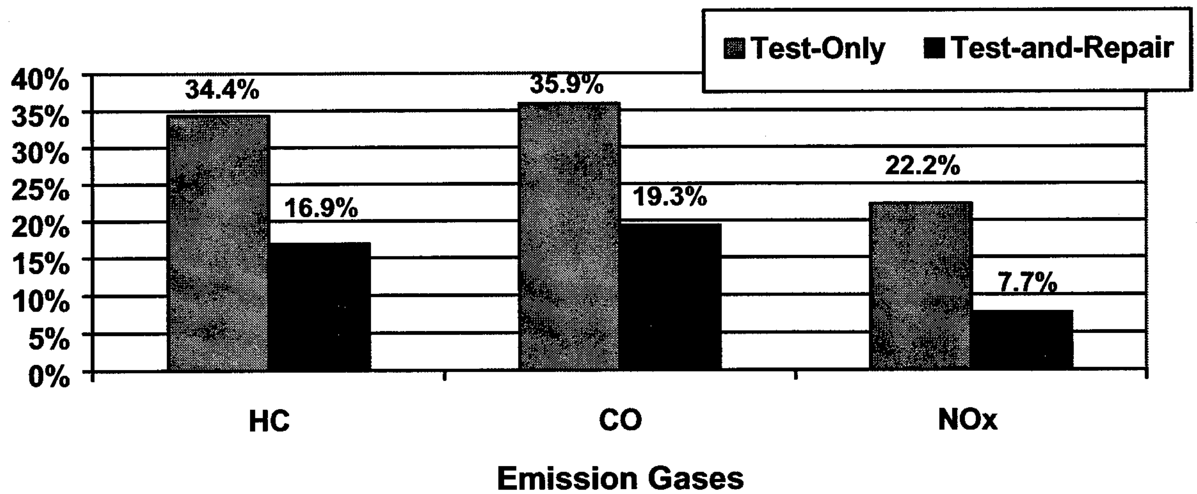
RSD – Use of Remote Sensing Devices

States with Major Research Activities – The following states have major research projects underway in the area on inspection/maintenance (I/M) program:

California – California has research underway in the following areas:

- **Program evaluation (Testing underway, 1st phase completed Dec 1999)**: California does extensive on-road tests to evaluate its I/M program. With assistance from the California Highway Patrol, the Bureau of Automotive Repair (BAR) pulls in-use vehicles over and performs an ASM test, as well as a limited functional and visual inspection when time permits. Inspections are conducted by state inspectors, and therefore provide an independent measure of the emission readings and the condition of vehicular smog equipment for California's vehicle fleet. Attachment A is a report evaluating the performance of different types of I/M stations used in California. Vehicles certified at Test-Only stations (which are similar in concept to Wisconsin's and Illinois' stations) had significantly lower emission rates after their I/M test than those certified at Test-and-Repair facilities. This is shown graphically on Figure CA-1, which was derived from the report on Attachment A.

FIGURE CA-1
Observed Emission Reductions
Percent Reduction in ASM 2525 Rates by Station Type



This figure compares the observed emission reductions for vehicles tested at Test-Only stations with Test-and-Repair facilities. Results are expressed in terms of percent reduction in ASM 2525 emissions. The sample of vehicles certified at Test-Only stations show much greater emission reductions than the sample certified at Test-and-Repair stations.

- **Low Income Repair Assistance Program (LIRAP) (Underway)** – California was one of the first states to set-up LIRAP. The LIRAP program offers qualified motorists two types of assistance:
  - $1,000 for scrapping the vehicle.
  - Co-pay of $20 to $100 for repairs up to $500 in cost.

  In order to qualify for LIRAP, the vehicle must have been designated to be tested at Test-Only facilities, and fail inspection. California requires likely high emitting vehicles to be tested at Test-Only facilities. Additionally, the motorist must have owned the vehicle for at least 2 years, and to qualify for the scrappage option, the vehicle must be drivable. About 2,000 vehicles per year are scrapped or repaired as part of LIRAP.

- **Remote Sensing (in planning phase)** – California is planning to restart their OREMS (On-Road Emissions Measurement System) program. The OREMS program is intended to identify high emitting vehicles and require them to be inspected at specially licensed Smog Check stations. The Bureau of Automotive

Repair issued a request for proposals in mid-2001 but did not receive any response. They are reworking their request and plan to reissue it soon.

- **Liquid Leakers and other vehicles with evaporative emission problems (Implementation underway)** – BAR is developing an easier and more comprehensive evaporative emissions test for I/M programs. BAR is evaluating an improved pressure test, an evaporative canister condition check, a liquid leak check, an I/M lane "sniffer test", and a targeted thorough mechanic check up. Only some of these tests will become real options for I/M program. At this point, the liquid leak test and the improved pressure test seem to be likely candidates.
- **OBDII/OBDIII (Implementation underway)** – California continues to evaluate OBDII systems and recommend new features that they should have. In addition, California continues to evaluate OBDIII – remote identification of vehicles with faults. BAR is studying false failures and false passes for the OBDII test. BAR also is studying alternatives for performing OBD inspections, and whether OBDII-equipped vehicles should receive tailpipe tests.

Arizona – The state of Arizona has contracted with Eastern Research Group (ERG) to conduct the Arizona Alternative Compliance and Testing Study (AZACTS). This study includes a comprehensive assessment of different vehicle emissions reduction technologies that are currently available, or will be available in the near future. These include:

- on-road and controlled RSD measurement;
- centralized lane and remote scans of OBD systems, including methods to encourage drivers to respond to illuminated MILs;
- high emitter profiling;
- profiling in conjunction with RSD;
- PM measurement techniques;
- techniques to identify vehicles with high evaporative emissions;
- use of existing and improved repair data;
- vehicle early retirement; and,
- targeted retrofits.

Preliminary results of AZACTS will be available in June, 2002.

Virginia – The Virginia Department of Environmental Quality (DEQ) has contracted Environmental Systems Products (ESP) to conduct a remote sensing device (RSD) study in the Northern Virginia Enhanced Inspection and Maintenance (I/M) Program Area. Remote sensing has been included in the I/M State Implementation Plan revisions submitted by DEQ. The goals of the future comprehensive remote sensing program will be:

- To identify high-emitting light duty vehicles and trucks operating in the program area for out-of-cycle "verification" testing and subsequent repair
- To use RSD for "clean screening" of very clean vehicles, enabling these vehicles to avoid the regularly scheduled biennial emissions inspection test,
- To identify vehicles regularly driving in the I/M area that have not undergone an emissions inspection at a Virginia Certified Emissions Inspection Facility, and
- To evaluate fleet emissions and I/M program effectiveness.

DEQ intends to use information gathered during its RSD study to:

- Compare the emission test results from the existing I/M program area with the emissions as measured by remote sensing.
- Determine the overall feasibility and cost effectiveness of operating a future comprehensive remote sensing program in the Northern Virginia Enhanced I/M Program area,
- Determine the percent of "transient vehicles" not registered in the I/M program area and determine which of these are habitual commuters,
- Assess fleet emissions in the existing northern Virginia I/M area,
- Draw conclusions as to the effectiveness of the existing I/M program,
- Assess (if possible) visible emissions from both diesel and gasoline powered vehicles, and
- Assess the vehicle miles traveled (VMT) distribution of vehicles within the I/M area by vehicle age and body style.

The study will be completed by fall, 2002.

Missouri - The Missouri Department of Natural Resources oversees a centralized I/M program in the greater St. Louis area, the Gateway Clean Air Program. The program was the first in the United States to utilize a clean screen program to reduce the number of vehicles that are required to receive emissions tests. Under the RapidScreen program, vehicles from the most recent two model years are exempt from the inspection, comprising 11-15% of the fleet, and an additional 25-29% of vehicles that are targeted as low-emitters are exempted, for a total of 40% of the fleet. When vehicles are identified as low emitters, the owner receives a letter that the vehicle is not required to receive their regular I/M inspection.

Originally, vehicles could be identified as low emitters in one of three ways:

1. The vehicle passes two remote sensing observations on two different days (a vehicle passes by meeting remote sensing cutpoints).
2. By receiving a passing remote sensing measurement one time, and by also having a low score on the Low Emitter Index tool (the score represents the probability of failing the inspection). Because the vehicle is only observed on the road one time under this option, the RSD cutpoints are stricter than for option 1.
3. By receiving a low score on the Low Emitter Index, where the cutoff score is lower than for option 2, because no on-road measurement is available. This option does not

include the observation of the vehicle on the road, and resulted in some inspection exemption letters being sent to owners of vehicles no longer in the area. Because of the public perception problems that this caused, this third option was discontinued.

The Low Emitter Index (LEI) provides a failure probability for each model year, make, and model combination, based on historical test results from Colorado and Illinois.

A total of 5.6 million remote sensing records were collected over the two-year time period being reported. During this time, a total of 294,000 vehicles were identified as low emitters, and the owners sent notices of exemption. Of those, 61,000 were identified by remote sensing alone, 64,000 were identified by a combination of remote sensing and the LEI, and 168,000 were identified with the LEI alone. 65% of the exempt-eligible vehicles took advantage of the exemption (some motorists may have thought the notice they received was junk mail or otherwise disregarded it), for a total of 191,000 exemptions.

The performance of the RapidScreen program was measured through the use of a 2% random sample of vehicles that were identified as low emitters but not notified of an exemption. These vehicles were tested, and their emissions levels and failure rates used to evaluate the success of RapidScreen at identifying low emitters. The tailpipe failure rate for these vehicles was very low: for vehicles identified by RSD alone it was 0.3%, with RSD and LEI it was 0.6%, and with LEI alone it was 1%. Overall failure rates, which include gas cap pressure test results as well, were somewhat higher: 1.3%, 2.2%, and 2.3% for RSD-only, RSD and LEI, and LEI-only vehicles. By combining these results and fleet-wide average emissions reductions for vehicles that failed and then passed the inspection, it was estimated that the I/M program retained 95.5% of exhaust HC emissions reductions, 96.7% of CO reductions, and 90.6% of NOx reductions. The failure rate for the gas cap test for the screened vehicles was somewhat higher, so only 80% of evaporative emissions were retained.

In summary, the program exempted almost 40% of the fleet from the I/M inspection with relatively low levels of lost emissions reductions.

Oregon – Oregon is investigating the feasibility of setting up kiosks where motorists can perform their own OBDII inspections. The kiosks would likely be located at existing centralized inspection sites. Motorists would drive up and perform an OBDII inspection by following the prompts on the screen. A completion date for this investigation has not been established.

State Contacts

Appendix C contains a list of contacts in state I/M programs.

3.0 STATUS OF CURRENT I/M TECHNOLOGY

3.1 OBDII

All 1996 and later model year vehicles sold in the U.S. contain the second generation of on-board diagnostic equipment (OBDII). OBDII systems monitor all components that make up the engine management system. They can detect malfunctions or deterioration of these components, often well before the motorist becomes aware of any problem. All 1996 and newer vehicles use the same type of connector, common computer "languages", and the same criteria for evaluating the powertrain systems and indicating problems to the driver and the repair technician. When a problem that could cause a significant increase in emissions is detected, the OBD system turns on a dashboard warning light to alert the driver of the need to have the vehicle checked by a repair technician. In addition, the specific nature of the problem is recorded in the OBDII unit for easy retrieval.

EPA expects states to begin inspecting vehicles by interrogating the OBDII . EPA believes that OBDII systems can identify vehicles with serious emission control malfunctions more accurately and cost-effectively than traditional tailpipe tests, and help technicians diagnose and repair them.

Several states including Wisconsin have implemented OBDII inspections or plan to implement them in the next year. Despite the success of many of these programs, several issues still need to be addressed, including the following:

- Effectiveness of OBDII inspections vs. Tailpipe tests
- How to improve the response to OBDII warning lights (MIL)
- Stand-alone OBDII Systems

These issues are reviewed in this section, after the status of Wisconsin's OBD program is discussed.

3.1.1 Analysis of Data from Wisconsin's OBDII Inspection Program

Wisconsin started mandatory OBDII inspections in July 2001. Vehicles fail Wisconsin's OBDII inspection if they have the following conditions:

- MIL[5] does not illuminate during the key on engine off (KOEO); or
- MIL is commanded on by the PCM (on board computer).

If the vehicle has more than two monitors not ready or the test system cannot communicate with the vehicle, it receives an IM240 test.

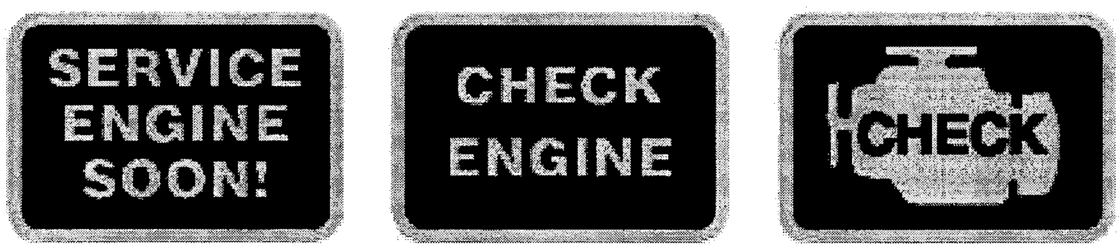
[5] Malfunction Indicator Lamp (MIL) is a term used for the light on the instrument panel, which notifies the vehicle operator of an emission related problem. The MIL is required to display the phrase "check engine" or "service engine soon". The ISO engine symbol also may be used as a substitute for the word "engine".

[6] OBDII systems must indicate whether or not the onboard diagnostic system has monitored each component. Components that have been diagnosed are termed "ready", meaning they were tested by the OBDII system.

dKC collected and analyzed data from Wisconsin's OBDII I/M program. dKC also collected and analyzed data from OBDII I/M programs in Illinois and Oregon. Following is a summary of the key results.

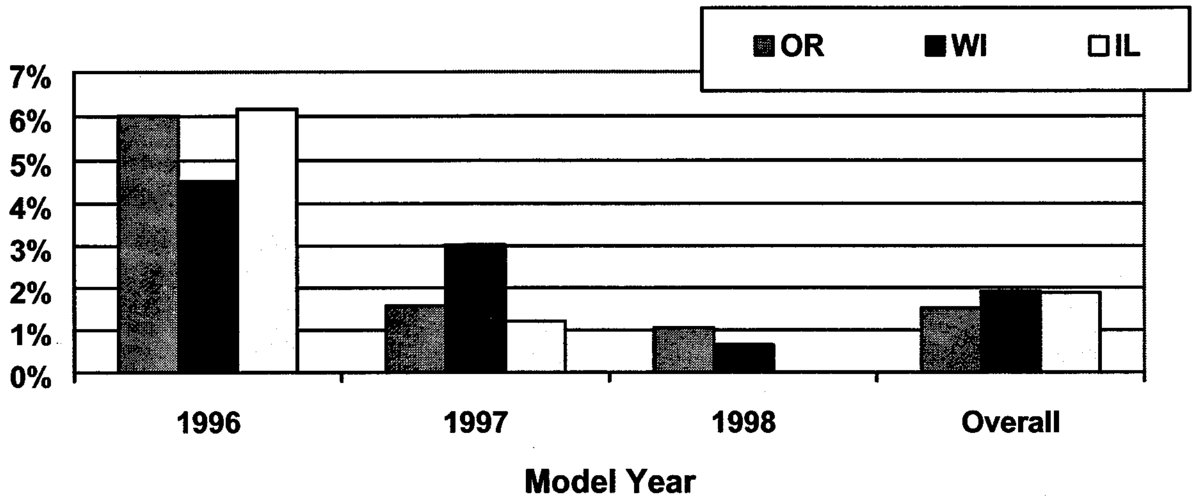
MIL Illumination Rates

Malfunction Indicator Lamp (MIL) is a term used for the light on the instrument panel, which notifies the vehicle operator of an emission related problem. The MIL is required to display the phrase "check engine" or "service engine soon". The ISO engine symbol also may be used as a substitute for the word "engine". MIL-command status is the term used to indicate if the vehicle's OBD system has commanded the MIL to turn on based on a malfunction.



As shown in Figure 1, the fraction of vehicles with illuminated MILs in Wisconsin is similar to the fractions observed in Oregon and Illinois. Wisconsin appears to have a higher than average fraction of 1997 model year vehicles with illuminated MILs, but the sample size for this model year group is very small because it was an off year for testing them. Overall, the fractions of vehicles in Wisconsin with MILs commanded on is very similar to those observed in other I/M programs.

Figure 1
Percent of Vehicles with MILs Commanded-On



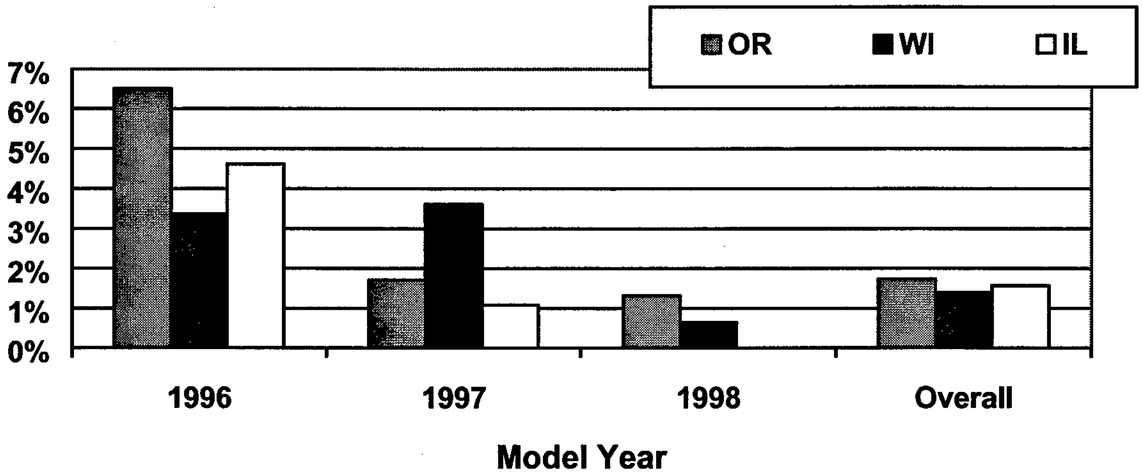
Readiness Trends

OBDII systems must indicate whether or not the onboard diagnostic system has monitored each component. Components that have been diagnosed are termed "ready", meaning they were tested by the OBDII system. The purpose of recording readiness status is to allow inspectors to determine if the vehicle's OBDII system has tested all the components and/or systems.

According to EPA guidelines, vehicles should be rejected from testing if they have more than two monitors that are not ready. Currently in Wisconsin, such vehicles receive an IM240 test. If they fail the test, they must be repaired. If they pass the test, they pass the inspection. There is concern that this provision gives motorists the incentive to extinguish illuminated malfunction indicator lights (MILs) by having technicians clear codes just prior to inspection[7]. When codes are cleared, all the monitors are set to not ready. Based upon an analysis of data from Wisconsin, Illinois, and Oregon, Wisconsin does not have higher than average percentages of vehicles with more than two monitors not ready. This is shown graphically in Figure 2. Oregon fails vehicles that are not ready so it should not have inflated "not ready" rates. Also, as shown earlier in Figure 1, Wisconsin has average percentages of vehicles with illuminated MILs. It does not appear that clearing codes is a problem in Wisconsin. Appendix A contains details on the readiness status of individual monitors.

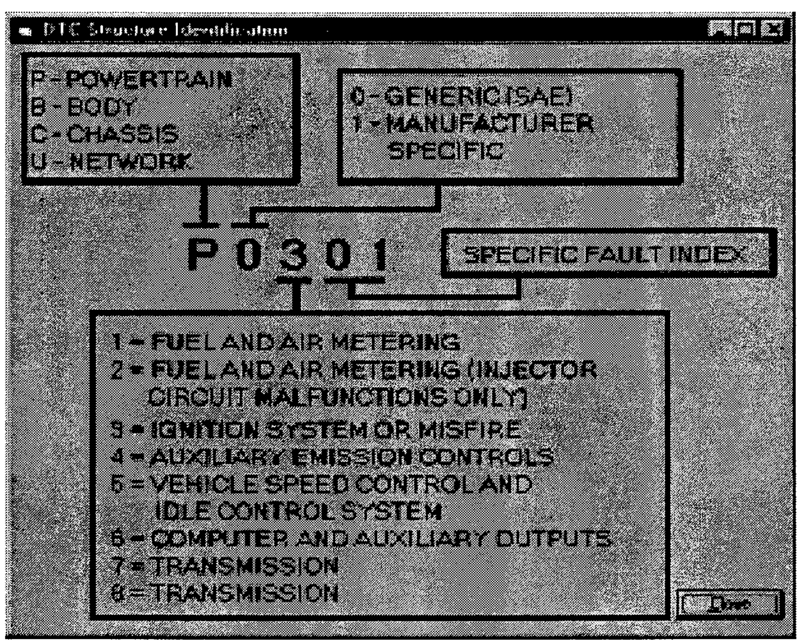
[7] All non-continuous monitors such as the catalyst and evap monitors set to "not ready" when codes are cleared to extinguish the MIL.

Figure 2
Percent of Vehicles with More Than 2 Monitors Not Ready



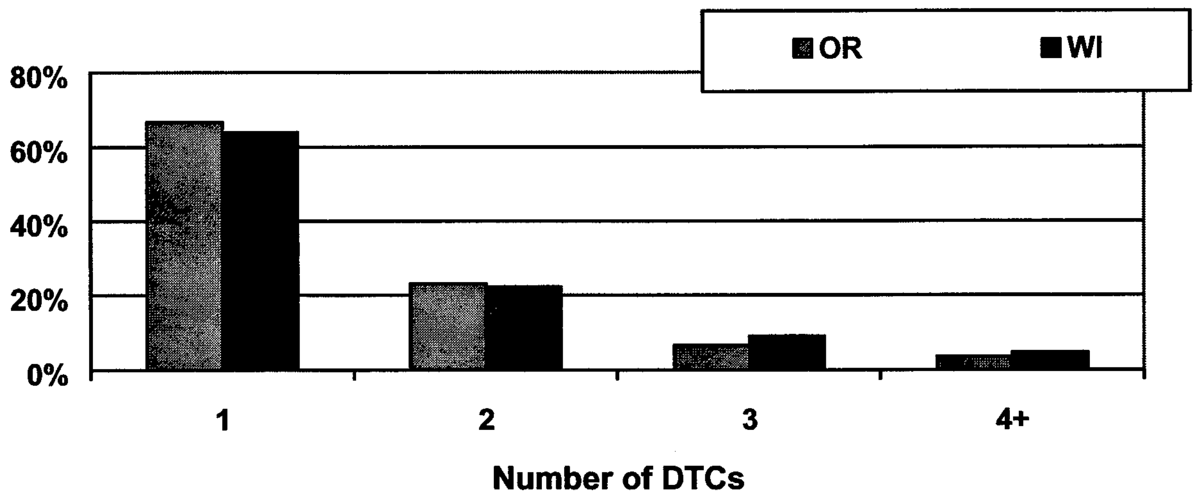
Diagnostic Trouble Codes (DTCs)

When the MIL is commanded-on, the vehicle should have one or more diagnostic trouble codes (DTCs) stored in the PCM (on-board computer). DTCs are how OBDII identifies and communicates to technicians where and what on-board problems exist. The first number in the DTC indicates whether the code is an SAE standard code (applies to all OBDII systems) or is specific to the vehicle manufacturer. The remaining three numbers provide information regarding the specific vehicle system and circuit. An analysis of a typical OBDII code is shown below.



The number of DTCs observed in Wisconsin compares well with the number observed in Oregon (Figure 3). Over 60% of the vehicles with illuminated MILs have only one DTC. Also the specific DTCs observed in vehicles with illuminated MILs in Wisconsin are very similar to those observed in Oregon and Illinois. This finding means that states can collectively pool resources and develop targeted repair procedures that are DTC specific. For example, specific repair procedures could be developed for vehicles with a P0401 (a common DTC for inadequate EGR flow). Even with no major preparation, technicians already are more successful in repairing OBD failures than tailpipe test failures, based on discussions with I/M personnel in Oregon and Wisconsin.

Figure 3
# of DTCs in Vehicles with Illuminated MILs



Tables 3 and 4 show DTCs compiled from OBDII inspection results in Oregon, Illinois and Wisconsin. Table 3 shows DTCs in vehicles with MILs commanded-on that had odometer readings less than 75,000. Table 4 shows DTCs in vehicles with more than 75,000 miles on them. The DTCs for the two groups are similar with the notable exception of catalyst codes which are at the bottom of the low mileage group but the top of the high mileage group. This makes sense, since deteriorated catalysts are expected to be more prevalent among high mileage vehicles. More details on DTCs from Wisconsin's OBDII fleet are presented in Appendix A.

Table 3
Top 10 DTCs in Vehicles with Illuminated MILs with Less Than 75,000 Miles (OR, WI, and IL)

DTC	% of Vehicles	Interpretation
P0401	7.75%	EGR Flow Insufficient
P0440	7.62%	Evap Malfunction
P0171	7.15%	System too lean -- Bank 1
P0133	6.25%	O2 Sensor Slow Response
P1443	5.82%	Ford Evap Control Valve Failure
P0300	5.29%	Random Misfire
P0141	4.72%	O2 Sensor Heater Circuit
P0174	4.36%	System too lean -- Bank 2
P0134	4.29%	O2 Sensor No Activity
P0420	**4.22%**	**Low Catalyst Efficiency – Bank 1**

Table 4
Top 10 DTCs in Vehicles with Illuminated MILs with Greater Than 75,000 Miles (Note that the most common DTCs relate to catalysts)

DTC	% of Vehicles	Interpretation
P0420	**16.10%**	**Low Catalyst Efficiency – Bank 1**
P0401	13.93%	EGR Flow Insufficient
P0430	**9.72%**	**Low Catalyst Efficiency – Bank 2**
P0133	9.21%	O2 Sensor Slow Response
P0171	8.63%	System too lean -- Bank 1
P0141	6.75%	O2 Sensor Heater Circuit
P0300	6.57%	Random Misfire
P1443	6.46%	Ford Evap Control Valve Failure
P0174	5.84%	System too lean -- Bank 2
P0153	4.35%	EGR Flow

Tailpipe Emissions vs. OBDII Result

Wisconsin, Illinois, and California perform tailpipe emissions tests on some of the vehicles that received OBDII inspections:

- Wisconsin performs IM240 tests on vehicles that are not ready or do not communicate with scan tool.
- Illinois performs OBD tests and IM240 tests on 1996 and newer vehicles.

- California performs OBD tests and ASM tests on 1996 and newer vehicles

Figure 4 shows IM240 levels for 1996 and newer vehicles tested in Wisconsin. Vehicles in Wisconsin that were not ready were observed to have higher tailpipe emissions than those that received IM240 tests because the test system could not communicate with the vehicle. This implies that some vehicles are not ready because sometimes the motorist or technician has cleared codes to extinguish the MIL. As mentioned above, however, it does not appear that motorists are abusing the OBDII system in this manner.

Figure 4
WISCONSIN RESULTS: IM240 Emissions (g/mi.) vs. Ready Status
(Note that IM240 Emissions are Much Higher for vehicles that were not ready)

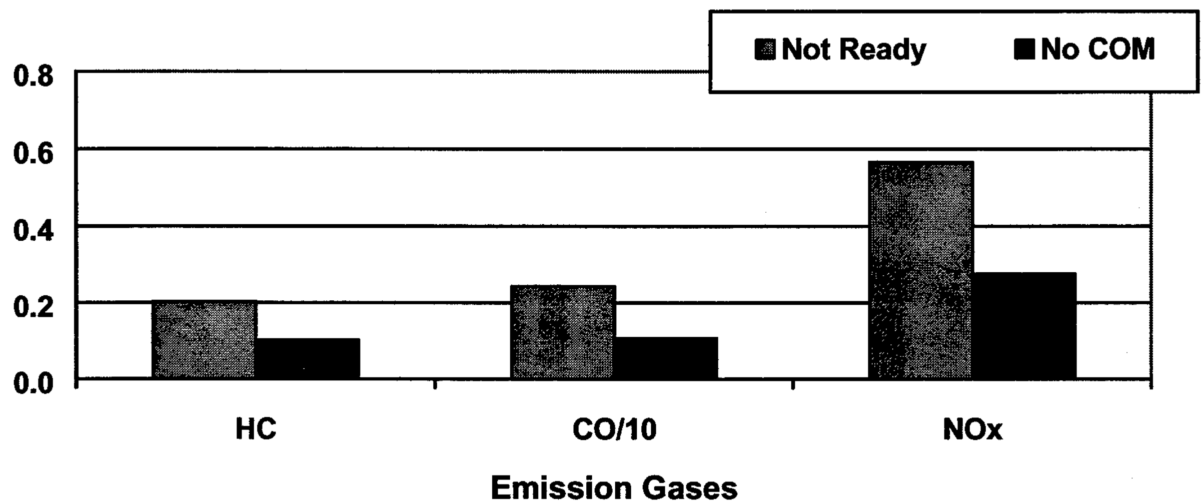
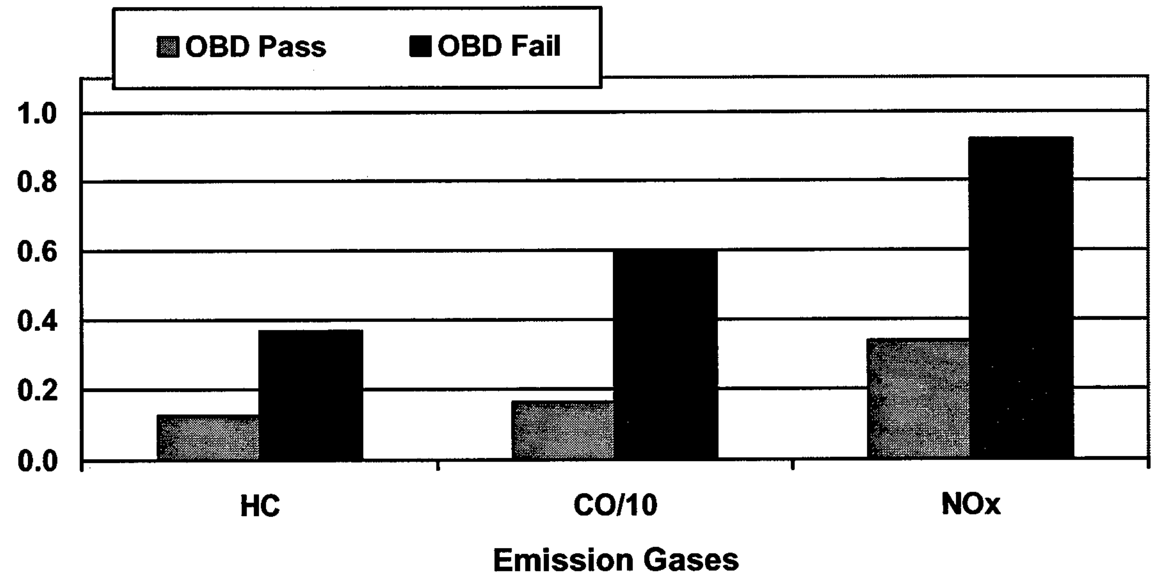


Figure 5 shows average IM240 emissions vs. OBD pass/fail status based on data from Illinois, during the advisory OBD period. A vehicle was classified as an OBD failure if the MIL was commanded-on or it was not-ready. Average IM240 emissions for vehicles passing the OBD inspection were about three-times as high as for vehicles failing the OBD inspection.

Figure 5
ILLINOIS ADVISORY OBD RESULTS: IM240 Emissions (g/mi.) vs. OBD Pass/Fail Status (Fail for MIL Status or Not Ready)



Additional results of IM240 tests and OBD tests on 1996 and newer vehicles in Illinois are summarized below:

- 1.59% of OBD Equipped Vehicles failed Emissions.
- 10% of OBD MIL-On Failures failed Emissions.
- 10% of vehicles that were not-ready failed Emissions.
- 42% of Emission Failures failed for OBD MIL-On or Not Ready.

Other I/M programs also perform dual tailpipe and OBD tests. California investigated the relationship between ASM test results and OBD test results. The ASM test is a loaded-mode test where vehicles are tested at two speeds: 15 MPH and 25MPH. ASM results are reported two ways: 1) vehicles exceeding ASM cutpoints and 2) the subset of ASM fails that are classified as gross polluters. Only 34% of the vehicles exceeding ASM standards failed the OBD inspection. However, 68% of gross polluters failed OBD.

Summary

Based upon an analysis of data from Wisconsin's, Oregon's and Illinois' I/M program, Wisconsin's OBDII program appears to be effective. Wisconsin appears to be failing the expected percentage of vehicles and has not reported difficulty in getting vehicles to comply with OBDII requirements.

3.1.2 Effectiveness of OBDII inspections vs. Tailpipe tests

The effectiveness of OBDII inspections is a major focus of EPA's FACA OBDII Policy Group. EPA is responsible for assuring that OBDII inspections will catch most of the high emitting vehicles. It is not Wisconsin's responsibility to enforce the accuracy of OBDII systems. EPA should be encouraged to perform surveillance tests on OBDII equipped vehicles, Also, EPA should continue to collect and review information on vehicles that receive both IM240 type tests and OBDII inspections. However, it is not Wisconsin's responsibility to perform these tests. Accordingly, dKC does not recommend that Wisconsin perform dual IM240 and OBDII inspections.

Several states have expressed concern that OBDII test results do not agree with results of tailpipe emission tests. For example, as noted above only 42% of the emission failures in Illinois failed the OBDII inspection. There is a logical explanation for the lack of correlation - these are two different types of tests.

- The IM240 test is a snapshot of the emission characteristics of a vehicle when it is undergoing inspection.
- The OBD inspection is a look back at the diagnostic history of the vehicle to determine if the vehicle has set any diagnostic trouble codes (DTCs) that could indicate that the vehicle has an emission related problem.
  - Many DTCs are related to evaporative emission tests (refer back to Table 3); these problems will not show up in exhaust emission tests.
  - Vehicles could have high emissions without the MIL being illuminated if the onboard computer (PCM) has not seen a repeat occurrence of a malfunction that would illuminate a MIL.
  - A vehicle could set a DTC in an emission related system, for example random misfire, but not yet show excessive vehicle emissions, because the catalytic converter temporarily consumes the excess emissions.

EPA's FACA workgroup has crafted a more detailed explanation for the lack of overlap between tailpipe and OBD tests, which is presented later in this report.

Several states are investigating whether high mileage vehicles with OBDII systems should receive tailpipe tests if they fail their OBDII inspection and face costly repairs. Many are including passing tailpipe tests in requirements for receiving waivers.

Research Recommendation – Wisconsin should conduct evaluations on high mileage OBDII vehicles that fail the inspection to determine if they need special inspection provision. Wisconsin needs to monitor EPA's research and conduct its own evaluations of the need for tailpipe tests, particularly for high mileage vehicles. In addition, the State needs to determine if waivers should be issued for high mileage OBDII vehicles that fail inspection.

3.1.3 Response to Malfunction Indicator Lamps (MIL)

Theoretically, I/M programs would not be needed in the future if motorists would respond to most illuminated MILs. Focus groups have been convened to determine how to improve driver's response to illuminated MILs.

CSU Focus Groups

Colorado State University (CSU) has been conducting focus groups to gauge driver understanding of and response to MILs. This section reviews results of focus groups that were conducted in Vermont. Vermont has been conducted OBDII inspections since July 1999. The groups addressed the following:

- Awareness of OBD II system
- Understanding of the MIL
  - What it indicates
  - What action it causes
- Reactions to being informed about OBD II
- Likely action when understanding the purpose of OBD II
- Reactions to other ways of explaining OBD II

The focus group sessions used the following techniques to solicit responses from the participants:

- Reactions to MIL on panel mock-up (written)
- Discussion of interpretation of light
- Response to information about OBD II
- Review of expected communication methods
- Review of alternative messages
- Response to communication materials

What do they know about the malfunction indicator light (MIL)?

A key issue explored by CSU's focus groups was knowledge of the MIL and what you should do when it illuminates. Like Arizona's group, participants knew little about the MIL. Responses to questions about the MIL are summarized below:

- Participants were confused and concerned when the light came on:
  - Immediate breakdown?

- Need to pull over?
  - Over-heating?
  - Time for routine maintenance?
- The following resources were consulted by some of the participants:
  - Manual
  - Mechanics
  - Relatives/friends
- Participants had virtually no understanding of the MIL and its relationship to emissions
  - General nature of message "Check Engine" or "Service Engine Soon" and mysterious icon (radiator? submarine? helicopter? coffeepot?) add to confusion.
  - Previous meaning of light in non-OBDII vehicles is a confounding factor. It used to remind them of maintenance.
  - Prior experience has taught that light can be ignored.
  - Some thought flashing light[9] indicates more serious problem.
  - Others thought flashing light indicates less serious problem (bad light or system can't make up it's mind).

The participants had the following specific comments about the MIL:

> "My first thought was 'What's my engine temperature?' I'm always worried that it's going to blow up."
>
> "I would stop. I'm very car-illiterate... I would stop and look in the manual."
>
> "I would have pulled over and looked for something obvious — something over-heating or leaking or a broken belt."
>
> "Every 2000 miles the "Check Engine Light comes on when your engine needs to be serviced, and they just re-set it."
>
> "When it came on before, I ended up taping over it because it wouldn't go off. I asked my mechanic about it, and he said I didn't have to worry bout it. It's just routine. They come on at a certain mileage interval when maintenance is due. You can have it re-set, or you can use duct tape."
>
> "I heard from my in-laws that it was a routine issue that would not affect the car's functioning... and it would be okay to ignore it. It kept going on and off. I ignored it for a year until I traded in the car."

[9] The MIL flashes once per second when a problem occurs that could damage the catalytic converter (e.g., severe misfire).

"I checked the manual. The way the manual was written was like 'Stop immediately. Get off the road. Call your dealer' ... It said something serious was wrong. I brought it in, they looked it over, and said it was just a malfunction of the light. There was nothing wrong with it."

"Two things: one is the safety of the environment and the other is am I going to get home or am I going to have to walk? The fact that I'm going to be able to get home might make me a little lax in the follow-up. I'll do it when I have time, not necessarily right away. As long as it's not going to interfere in my daily life, then it would be something I'd get done eventually, It's not real urgent."

"With the emissions, I would not worry. I would think it doesn't really affect me, and when I take it in for the yearly inspection, I'll find out if it is really a problem."

"I didn't make the connection (with emissions) but it would only be an issue of when you're due for an inspection. I'm not a fan of polluting, but it would have nothing to do with the operation of the car."

What's the best way to communicate the features and benefits of OBDII system?

The group was asked to suggest what public awareness messages could be used that would enhance drivers' response to MIL illumination. The offered the following suggestions:

- Protects the quality of the air
  - Because it is designed to warn the driver of a problem with emissions before the vehicle becomes a significant polluter, a potentially significant problem (e.g. a problem with your catalytic converter) can be averted before it occurs
- Can save you money two ways
  - Early detection and repair can often prevent more costly repairs on both emission control systems and other systems that might affect the performance of your vehicle
  - Early detection and repair can ensure that your car is getting the best possible gas mileage, thus saving you money on gas.
- Can protect the overall performance of your car
  - Early detection and repair of problems means that your car will perform at its best and last longer
- Most Persuasive Message
  - Linking emissions to vehicle performance and linking performance with saving money is the strongest argument to convince drivers to heed the MIL
  - Limiting the message to concerns about the environment is not as compelling as the appeal to the pocketbook.

Explaining the link between high emissions and performance is necessary but not sufficient by itself.

Arizona OBDII Research

As part of AZACTS (Arizona Alternative Compliance and Testing Study), Arizona is convening focus groups on OBDII, with a similar goal to CSU's study, i.e., determine how to improve drivers' response to illuminated MILs. Attachment B presents the outline for these groups. They will be completed by summer 2002. The first Arizona focus group found that although the level of awareness of the OBDII system is very low, the level of interest in its features and benefits is very high, once consumers are educated about it. The central conclusion to be drawn from this group is EDUCATION IS THE KEY. The group recommended that the State work with vehicle dealerships and service shops on consumer education, e.g., provide information in waiting rooms. In addition, the group found it appealing to be able to get their emission test at the same time the vehicle is in the shop for routine maintenance or other problems. Arizona like Wisconsin currently inspects vehicles in centralized test lanes.

Conclusions Concerning Focus Groups

Following are the key conclusions from the OBDII focus groups

- Although the level of awareness of the OBDII system is very low, the level of interest in its features and benefits is very high once consumers are educated about it. The central conclusion to be drawn from the focus groups is EDUCATION IS THE KEY.

- An effort to work with vehicle dealerships and service shops on consumer education appears to be the most effective education strategy, based on the reactions from participants.

- In addition, it would appear that a carefully-organized program to certify dealerships and major vehicle service businesses as remote emissions testing sites for 1996+ vehicles would be welcomed and utilized by a significant portion of consumers. The appeal of being able to get their emission test at the same time the vehicle is in the shop for routine maintenance or other problems is unmistakable. Participants in Arizona liked the idea of restarting the inspection clock when a vehicle is serviced for the MIL being on.

Research Recommendation – Focus group studies in Wisconsin, particularly in current non-I/M areas, are needed to determine the need for and make-up of future OBDII inspection programs.

3.1.4 Ways to Beat the OBDII Inspection

During the EPA FACA meetings, some officials have expressed concerns that it is possible to beat the OBDII inspection. There are essentially three major ways that motorists or inspectors can pass a vehicle that should otherwise fail the OBDII inspection.

- Use OBDII sensor simulators to trick the computer into passing the vehicle;
- Substitute a vehicle with no known OBDII problems for the one being inspected; and
- Clear codes and hope the problem does not resurface before the vehicle is inspected.

Cheater Devices – Recently there has been concern over the availability of sensor simulators that appear to be intended to help people pass an OBDII inspection. One of the sensor simulators that has been advertised on the internet simulates oxygen sensors upstream and downstream of the catalytic converter. The upstream oxygen sensor is frequently identified as functioning properly by the OBDII system. The downstream oxygen sensor is the key sensor used in monitoring catalyst deficiency. Cheater devices impair the effectiveness of the system in identifying oxygen sensor and catalytic converter problems, along with many other problems. At this time, we do not know how much these devices are used. It is expected that currently few vehicles have them, but the potential exists in the future for many more motorists to use them as OBDII inspections are expanded. They cost between $60 and $120, which is a lot less than a new catalytic converter (~$500). They are probably illegal but the penalties are unknown. Subsequent work will deal with the cost and penalty issues.

To address this problem, the inspection system software could be modified to identify vehicles that have non-characteristic signatures for different operating modes. For example, a cheater system would have to be very sophisticated to properly simulate oxygen sensor output under a wide variety of load and speed ranges. If these types of devices become a problem in the future, inspection system could be modified to include algorithms to look for sensors with suspect readings under various operating conditions.

Another way of identifying cheater devices would be to provide two-way communication between the test system and the vehicle. In this case, if a vehicle shows that all the monitors are ready and MIL is commanded off (i.e., it passes the test) the test system could command the on-board computer to clear codes which should set all the non-continuous monitors to not ready. If upon reinspection, the system continues to report all monitors ready, then this would be evidence that the system has been tampered with.

Clean Scanning – The problem of clean scanning has been given much attention, particularly in areas planning decentralized OBDII inspections. There are currently two parameters that are being collected by most I/M programs to help thwart clean scanning: PID Count and PCM module ID. There are several hundred combinations of PID counts and PCM module ID. In order to clean scan a vehicle you would have to find a vehicle with the exact combination of PID count and PCM module ID, and that could be difficult in many situations. In the future, when the vehicle identification number (VIN) is available, it will be even more difficult to clean scan a vehicle. Also, future changes in the OBD system including items such as the calibration verification number, will make it very difficult to tamper with the vehicle and to substitute a different vehicle for inspection.

Other potential forms of fraud include manipulation of the downloaded data (this can perhaps be defeated by encryption), and use of devices that are apparently available that allow a correct PID count and PCM module ID retrieval but mask the "MIL command" status and any stored DTCs (which would cause the vehicle to receive a "clean" test result). Currently, we are not aware of any of devices being used, but the potential exists.

Clearing Codes -- The problem of clearing codes without doing repairs already appears to be occurring, particularly for vehicles failing with catalyst codes. In a majority of the retests in OBDII I/M programs where vehicles failed with catalyst codes, the Catalyst Monitor had not yet set when retested. The Catalyst Monitor is usually one of the last monitors to reset to ready after clearing. It's possible that no repairs were done to many of these vehicles, and technicians instead just cleared codes to turn out the MIL. Wisconsin should consider requiring vehicles that failed with catalyst codes to have the Catalyst Monitor ready on retests, or pass an IM240 tailpipe test.

Research Recommendation – Wisconsin should stay in touch with other I/M programs and determine if and when OBD cheater devices are an issue to worry about. Wisconsin should routinely analyze I/M program data to determine if there may be a problem with vehicles that fail with catalyst codes passing retests with the catalyst monitor "not ready".

3.1.5 Stand-alone Decentralized OBDII Systems

Because test equipment is inexpensive, OBDII inspections can be performed in decentralized scenarios. Several states have implemented or are considering implementation of decentralized, stand-alone OBDII inspection programs. Inspection options include:

- Inspections in private garages (Current costs range between $10 and $20 per inspection).
- Inspections while refueling car (Costs could be less than $10 per inspection)
- Inspections at Oil Change Facilities (Costs could be less than $10 per inspection)
- Self-service kiosks (Costs could be less than $10 per inspection)
- **OBDII Self-Testing** – It's possible that the State could distribute hardware and software that allows motorists to use PCs or Palm Pilots to perform their own OBDII inspections. These systems could cost less than $50, plus the cost for the computer or palm pilot. The primary purpose of the system would be to allow motorists to comply with inspection requirements without the hassle of traveling to the inspection station and waiting for their vehicle to be inspected. The inspection would consist of attaching a computer to the vehicle's onboard computer and downloading standard information on the status of different emission related systems. After information is downloaded it could be transferred to the State's web site for processing.

Before the State considers implementing any of the above alternatives, the consumer acceptance and enforcements aspects must be thoroughly evaluated.

3.1.6 Future OBDII Requirements

Near-term developments include new OBDII inspection systems and changes in OBDII requirements by California and EPA. The California Air Resources Board (ARB) plans several changes in OBDII systems, beginning with the 2005 model year. Following is a list of proposed changes that are relevant to OBDII I/M programs:

- Calibration Verification Number (CVN): a means of assuring that the vehicle is using the correct computer chip; helps prevent clean scanning, the OBD equivalent of clean piping, and chip tampering.
- VIN: must be part of OBD data stream; also helps prevent clean scanning.
- Standardized Data Link Connector (DLC) location; helps inspectors find the the DLC.
- Generic scan tool test as part of vehicle certification; helps assure that test equipment can communicate with OBDII systems.
- Calibration ID (Cal ID): Must, at a minimum, uniquely identify vehicle model, model year, engine displacement, emission standard, and emission test group; also helps prevent clean scanning.

- Drive cycle info: Require drive cycles, drive cycle info, or monitoring conditions to be made available (for all 1996 and newer) to exercise monitors needed to set readiness codes. Must allow technicians to be able to operate all the diagnostics on a single drive cycle and to individually operate diagnostics (to verify only repaired component or set remaining one or two "not ready" monitors). Helps technicians and motorists get cars "ready" for the inspection.
- Standardized requirements for monitors to run during normal driving. Assures that monitors will run and that vehicles will be "ready" for inspections.
- Add indication of time since codes were cleared or battery was disconnected. Helps determine if vehicles may have had codes cleared before they were inspected.

Typically, EPA adopts the same OBDII requirements as California, so the above changes will most likely apply to 2005 and later federal vehicles.

3.1.7 OBDII Research for Wisconsin

Following are OBDII research recommendations for Wisconsin.

A. MIL Response Study – Conduct focus groups and surveys motorists, technicians, and auto dealers to address the following questions:

- How do you get motorists to respond to illuminated MILs?
- Is I/M the only way to keep vehicles with illuminated MILs from operating?

B. Stand-Alone OBDII Alternatives to Centralized Testing – Investigate alternatives to centralized testing of OBDII systems. Research is needed on the cost, enforceability and public acceptance of alternative ways of performing OBD inspections. Inspection options include:

- Inspections in private garages.
- Inspections while refueling car
- Inspections at Oil Change Facilities
- OBDII Self-Testing

C. Tailpipe Tests on High Mileage OBDII Equipped Vehicles – Investigate the need for tailpipe I/M tests on high mileage OBDII equipped vehicles.

- Can compliance with tailpipe tests be used as an alternative to OBDII repairs costing more than $1,000?
- If so, what should be the limits on such provisions?

D. Investigations into ways to cheat the OBD inspection – Wisconsin should stay in touch with other I/M programs and determine if and when OBD cheater devices are an issue to worry about. Wisconsin should routinely analyze I/M program data to determine if there may be a problem with vehicles that fail with catalyst codes passing retests with the catalyst monitor "not ready".

3.2 Finding Vehicles with Gross Evaporative System Leaks

Recent data have shown that a small percentage of vehicles classified as liquid leakers account for a significant fraction of the hydrocarbon emissions inventory. These vehicles typically have identifiable drops of fuel dripping from their fuel system. California estimates that the benefits of finding and repairing vehicles with liquid leaks are of the same order-of-magnitude as gas cap tests. As mentioned earlier, the California BAR is developing an easier and more comprehensive evaporative emissions test for I/M programs. This test would include an improved pressure test, an evaporative canister condition check, a liquid leak check, an I/M lane "sniffer test", and a targeted thorough mechanic check up.

Research Recommendation – Research is needed to determine how vehicles with gross evaporative system malfunctions or fuel leaks can be identified and repaired. The benefits from finding and repairing these vehicles are significant, but finding them is a challenge, especially in a typical inspection lane. The following specific issues must be addressed:

- How do you test a vehicle to determine if it has liquid leaks?
- Can these vehicles be identified and repaired on a voluntary basis? Should after repair data be sent to the state?
- Are there companies or organizations that will bank and trade credits for identifying liquid leakers?

3.3 Particulate/Diesel Emissions Control Programs

Several states have implemented measures to reduce particulate emissions from motor vehicles. The following activities have been implemented:

- I/M Inspections
- Smoking Vehicle Hotline
- Roadside Diesel Testing Pilot Program

Most of these activities focus on diesels, but programs, such as Smoking Vehicle Hotlines and visual smoke checks in I/M programs also address gasoline-powered vehicles with excessive particulate emissions. Table 3 presents a summary that was prepared by ERG on the status of diesel inspection programs in North America.

Two basic types of tests are used for diesel powered vehicle; snap idle tests following SAE surface vehicle standard J1667 and loaded mode tests. The snap idle test is primarily used for heavy-duty diesel vehicles because of the difficulty in performing loaded mode tests on them. In this test, the vehicle's throttle is depressed to full throttle position and then released. This is termed a snap idle. Three snap idles are performed, after an initial clean out. The average of the three snap idles is used to determine compliance. Loaded mode tests typically are performed under steady state low speed conditions with a moderate load. Most loaded mode tests are not very stringent and the failure rate generally is less than for a snap idle test. Remote sensing equipment developers are experimenting with systems that can measure opacity from heavy-duty diesel-powered while they are being driven, but these systems are not commercially available.

Most states use partial flow opacimeters to measure opacity. The test operator merely has to place the sampling probe into the exhaust pipe and start the test. With optional accessories, the unit can be programmed to track and record engine RPM, and to report smoke in one of several different ways.

The snap idle test has a great deal of practicality since it requires no equipment beyond the smoke measuring equipment. However, it is extremely important to ensure that the engine governor is set properly prior to the test, i.e., to ensure that the engine will not overspeed when the procedure is applied. Also, it is important that the procedure is conducted the same way each time, because operator variability is a concern. States report large reductions in opacity (as measured by the snap idle test), but reductions in the mass of particulate emissions are less certain, because snap idle test results do not correlate well with mass emission measurements.

To date, no diesel I/M programs have addressed NOx emissions due to the difficulty in testing diesels for NOx. In order to test a diesel vehicle to determine if it has excess NO_x emissions, the vehicle must be operated on a dynamometer. Dynamometers that are capable of testing heavy-duty diesels can cost upwards of $1,000,000. Alternatively, it may be feasible to remotely sense NO_x emissions from diesels as they are operating under load, for example, up a slight grade. Research indicates that remote sensing of NO_x emissions from diesels is feasible, but commercial systems have not yet been developed.

dKC recommends that Wisconsin revisit diesel I/M in the future, after remote sensing and other less obtrusive ways to test diesels are tested and proven.

Table 3. North American Diesel Inspection Program Summary (Prepared by ERG and Bill Dell)

State	Heavy/ Light Duty	Start Date	Model Years	Test Procedure	Frequency	HD Fines: 1st citation/2nd in 1yr	Cutpoints
AZ	HD	1999	67 and newer	SAE J1667	Random	Same as LD I&M Program	40% opacity for 1991 and newer 55% opacity for 1990 and older
AZ	LD		67 and newer	Loaded mode	Annual	Same as LD I&M Program	20% opacity < 2000 ft altitude 30% opacity 2000-4000 ft 40% opacity > 4000 ft altitude
CA	HD	1998		J1667	Random	$800/$1800	40% opacity for 1991 and newer 55% opacity for 1990 and older
CO	HD	1987	All	Loaded mode	Annual		35% opacity for naturally-asp. 20% opacity for turbo-charged
CO	LD		All	Loaded mode	Annual		40% opacity for naturally-asp. 35% opacity for turbo-charged
CT	HD	1998	All	J1667	Random	$300/$500	40% opacity for 1991 and newer 55% opacity for 1974 – 1990 70% opacity for 1973 and older
IL	HD	1992		Snap idle	Random	$400/$1000	40% opacity for 1991 and newer 55% opacity for 1974 – 1990 70% opacity for 1973 and older
MD	HD	1993	All	J1667		$1000/$1000	40% opacity for 1991 and newer 55% opacity for 1974 – 1990 70% opacity for 1973 and older
MA	HD	2001		J1667	Biennial		40% opacity for 1991 and newer 55% opacity for 1990 and older
NV	HD	1996	All			$800/$1500	70% opacity
NV	LD	1994	All	Loaded mode	Annual		40% opacity
NH	HD					$100/$500	40% opacity for 1991 and newer 55% opacity for 1974 – 1990 70% opacity for 1973 and older
NJ	HD	1997	All	J1667	Random and Annual	$350/$700	40% opacity for 1991 and newer 55% opacity for 1974 – 1990 70% opacity for 1973 and older
NY	HD	1999	All		Random and Annual	$700/$1300	40% opacity for 1991 and newer 55% opacity for 1974 – 1990 70% opacity for 1973 and older
OH	LD		25 yrs & newer	Loaded mode	Biennial		20% opacity
PA	HD	Pilot					
UT	HD		All	J1667	Annual		70% opacity
UT	LD		1968 and newer	Loaded mode	Annual		40% opacity
WA	HD	1993	1968 and newer	J1667			40% opacity for 1992 and newer 60% opacity for 1974 – 1991 70% opacity for 1968 - 1973
BC	LD	1992 update 1999		Loaded (IM147 trace)	Annual		various
BC	HD	1999		J1667	Random		40% opacity for 1991 and newer 55% opacity for 1990 and older
ONT	HD	2000		J1667	Annual	$500/$10,000	40% opacity for 1991 and newer 55% opacity for 1990 and older

3.4 Remote Sensing Programs

Many states have collected emissions data using remote sensing devices (RSD). With RSD, vehicle emissions are measured remotely by passing a light source across a highway to a source detector. The source detector measures absolute concentrations of hydrocarbons (HC), carbon monoxide (CO), nitrogen oxide (NO), and carbon dioxide (CO_2) in the diluted exhaust. From these measurements, exhaust concentrations of HC, CO, and NO in the undiluted exhaust are calculated. RSD offers the opportunity to obtain vehicle emissions measurements in a relatively non-intrusive manner.

Many states use RSD to collect emissions data in support of EPA's requirement to sample on road emissions from 0.5% of the fleet. Some states have more ambitious uses for RSD. California, Colorado, Missouri, Texas and Arizona have the most experience with the use of RSD. They have investigated its use for the following:

- I/M program evaluation
- Gross polluter identification
- Clean screening
- I/M program compliance

One of the most comprehensive studies of clean screening was performed for the state of Colorado. It covered the Greeley, Colorado area. The study found that clean screen could be used without significantly impacting the emission reductions from the I/M program in the Greeley area. However, the study also concluded that the cost to clean screen a vehicle considering the logistics of getting enough observations on an adequate sample of the population would equal the cost to perform a tailpipe emission test at a conventional I/M station, $15 for both cases.

In the early 1990s, Wisconsin researched remote sensing and concluded that it would not significantly enhance their effectiveness of its program. Wisconsin was concerned about errors of omission (false passes) and errors of commission (false failures).

Recently, the value of clean or dirty screen programs for vehicles with OBDII system has been questioned. There are many reasons why clean or dirty screen does not make sense for OBDII equipped vehicles.

- Clean or dirty screen results in a 10% to 30% emission reduction credit loss for a tailpipe test program. Since OBDII inspections are projected to result in greater emission reductions than tailpipe tests, the credit impact of a clean or dirty screen program on an OBDII inspection program will be even greater.
- Clean or dirty screening via RSD is expensive, costing about the same as an emission test per vehicle exempted. A stand-alone OBDII only test could be much less expensive.
- Clean or dirty screening cannot identify component failures that lead to high emissions later. By the time a vehicle shows high enough emission levels to register a

high RSD reading, it will likely have serious emission related problems, which will be expensive to repair.

- Clean or dirty screen programs would greatly reduce evaporative emission benefits of an OBD I/M program.

No additional research in this area is recommended at this time. The State should monitor results of Virginia's and Arizona's remote sensing studies to determine the value of remote sensing in the future. Also, the State should consider using remote sensing to evaluate its I/M program, if Virginia's remote sensing study yields important information about the effectiveness of Virginia's I/M programs.

3.5 Toxic Control Programs

I/M programs, reformulated fuels, Low-Emission Vehicle standards and other controls implemented for motor vehicles have significantly reduced toxic emissions. To date, states have not implemented additional programs that focus specifically on reducing toxic emissions from motor vehicles.

Existing programs such as I/M programs, low emission vehicle standards, and fuel controls are very effective in reducing toxic emissions because they reduce hydrocarbon emissions. Most toxic compounds of concern are hydrocarbons. Therefore, reducing hydrocarbon emissions reduces toxic emissions. In addition, reformulated fuels – by capping the percentage of aromatics and benzene in gasoline – provide additional toxic control benefits over and above those provided by across the board hydrocarbon reductions, because they help reduce the fraction of hydrocarbons that are toxic. Many states believe that the primary benefits from controlling motor vehicle emissions are from reduced toxic emissions, even though the programs were enacted primarily to reduce ozone levels.

Additional research into control measures for toxics is not recommended.

3.6 Supplemental Federal Test Procedure (SFTP)

Emissions can be more than 100 times greater during acceleration modes that are not represented in the FTP. EPA and the State of California developed the Supplemental Federal Test Procedure (SFTP) to ensure that emissions are not excessive during "off FTP" conditions, such as high acceleration modes. Light-duty vehicles sold since 2000 have had to meet these requirements. MOBILE6 allows states to evaluate the benefit of the SFTP requirement in reducing in-use emissions. MOBILE6 projects much lower emission levels in future light-duty vehicles, partly due to the SFTP effects.

Theoretically, compliance with the SFTP will increase the effectiveness of other mobile source control strategies. For example, the effectiveness of OBDII I/M programs should be improved, because the OBDII system will identify malfunctions that affect emissions during the SFTP as well as the FTP.

3.7 EPA Activities/FACA Group Activities

So far, EPA's OBD Policy workgroup has concentrated on the lack of overlap between exhaust emission test results and OBDII inspection results. Following is the latest explanation from the workgroup:

> *"The National Academy of Sciences (NAS), in its report, AEvaluating Vehicle Emissions Inspection and Maintenance Programs,@ expressed concern about the results of an assessment of Inspection and Maintenance (I/M) program lane data from Wisconsin. For example, the data showed that of 2,823 On-Board Diagnostics (OBD) and IM240 tailpipe test failures (1,479 and 1,344 respectively), only 173 vehicles failed both tests. Similar results have also been reported in other studies (including Colorado, Illinois and EPA).*
>
> *The 2,823 failures were a subset of a total of 116,667 vehicles tested, meaning that, for the purpose of identifying clean vehicles, the OBD-I/M test and the IM240 tailpipe test agreed more than 97% of the time. However, because the goal of I/M programs is to identify and repair dirty vehicles, EPA and state environmental agencies are committed to ensuring that whatever I/M test method is used is capable of accurately identifying vehicles that need emission-related repairs.*
>
> *Listed below are several reasons for the lack of overlap between the OBD-I/M tests and IM240 tailpipe tests in fewer than 3% of the tests where failures occurred.*
>
> - *The use of OBD in vehicle inspection programs represents a new paradigm. Studies have shown that OBD systems identify deteriorated or broken components or systems that lead to higher emissions. Additionally, OBD systems identify repairs needed to prevent further deterioration of broken emission control components.*
>   - *The use of OBD as an I/M test method is a very different approach than traditional I/M testing, with a much greater emphasis placed on preventing vehicle pollution from occurring before the vehicle is polluting over the*

standard, instead of an emphasis on detecting and repairing vehicles with excess emissions after the vehicle is polluting over the standard.

- *Data from EPA and other studies indicate that half or more of the OBD I/M test failures could fall into this preventative category. The EPA is currently conducting a life cycle analysis to investigate the full range of benefits to both the vehicle owner and the environment of OBD induced repairs on vehicles before catastrophic failure events occur.*

- *The OBD-I/M inspections also identify evaporative system purge and pressure failures; the IM240 tailpipe inspections do not. Identifying evaporative emissions (HC) will become increasingly important because studies have predicted that evaporative emissions will account for 60% of the total HC emissions from the overall fleet of OBD-equipped vehicles in future years.*

- *OBD systems are designed to identify vehicle emissions-related failures occurring during all types of operating conditions, in real-time. IM240 and other tailpipe test methods are designed to identify vehicle emissions-related failures occurring during a representative set of operating conditions at a one-time inspection every one or two years. For example, a component failure that results in higher NOx emissions only during highway driving would not necessarily be detected by a tailpipe test.*

- *Neither the OBD nor the traditional I/M tailpipe test is completely accurate. For example, some of the vehicles that failed the tailpipe test should have passed, while some of the vehicles that passed the OBD-I/M check should have failed (and vice versa).*

Overall, the EPA has confidence in both OBD and tailpipe testing as vehicle inspection and maintenance tools. OBD is the most efficient and effective approach to maintaining low emission levels for the future fleet of vehicles (1996 and newer model years). EPA is conducting an ongoing assessment of high-mileage vehicles to continue to monitor the operation of the OBD systems as they age. Traditional tailpipe I/M testing will still play an important role as the means of accurately identifying vehicles that need emission-related repairs for 1995 and older vehicles, and may be needed for OBD-equipped vehicles as they age. Overall, the Agency believes that both OBD and tailpipe testing remain important components of I/M programs."

While the above explanation presents a credible case for why OBDII fails some vehicles that pass tailpipe tests, many state officials still feel that the reverse problem, vehicles that pass OBDII tests but fail tailpipe tests, needs further explanation.

Appendix B contains the minutes of the last two FACA policy workgroup meetings, along with its charter and a list of its members.

APPENDIX A – ADDITIONAL OBD STATISTICS

READINESS TRENDS BY MONITOR BASED OBDII DATA FROM WISCONSIN, ILLINOIS AND OREGON

Figure A-1
Percent of Vehicles with More Than 2 Monitors Not Ready

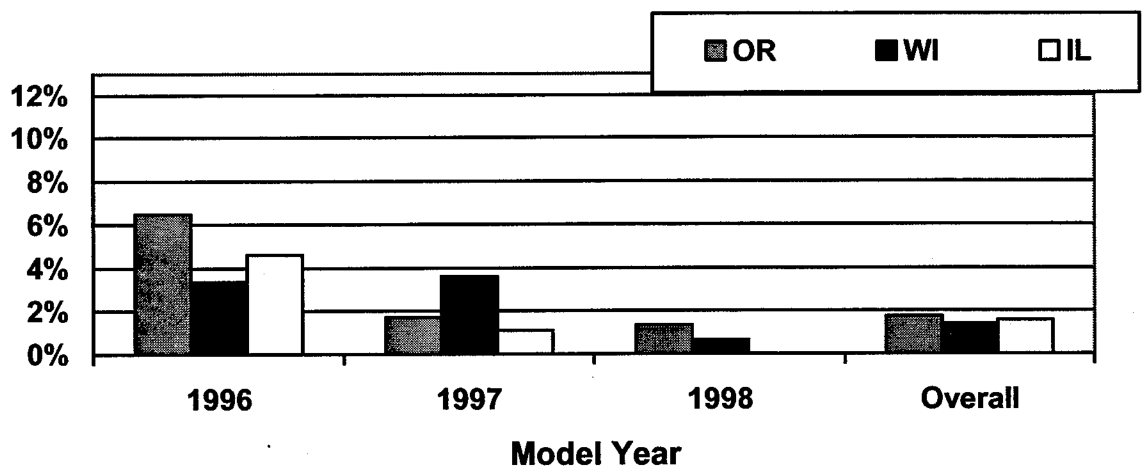


Figure A-2
Percent of Vehicles with O2 Sensor Not Ready

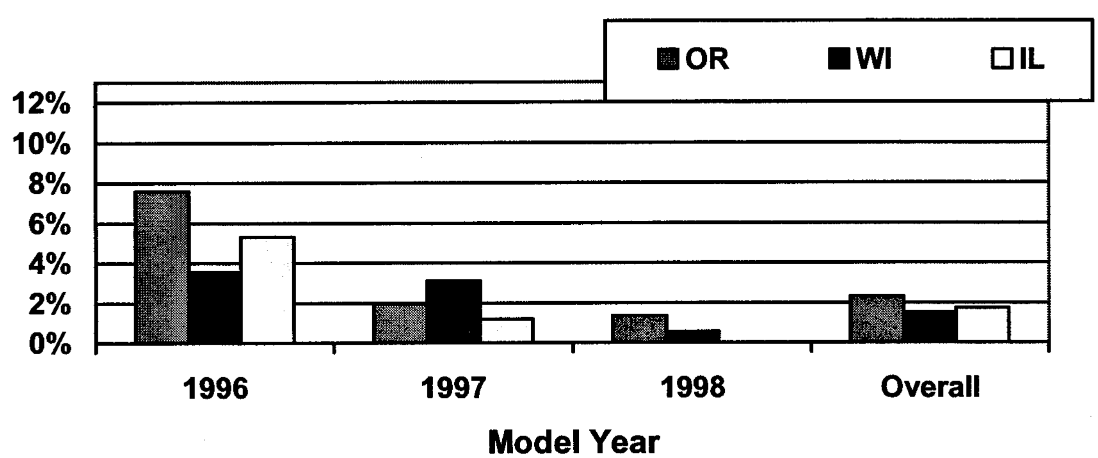


Figure A-3
Percent of Vehicles with O2 Sensor Heater Not Ready

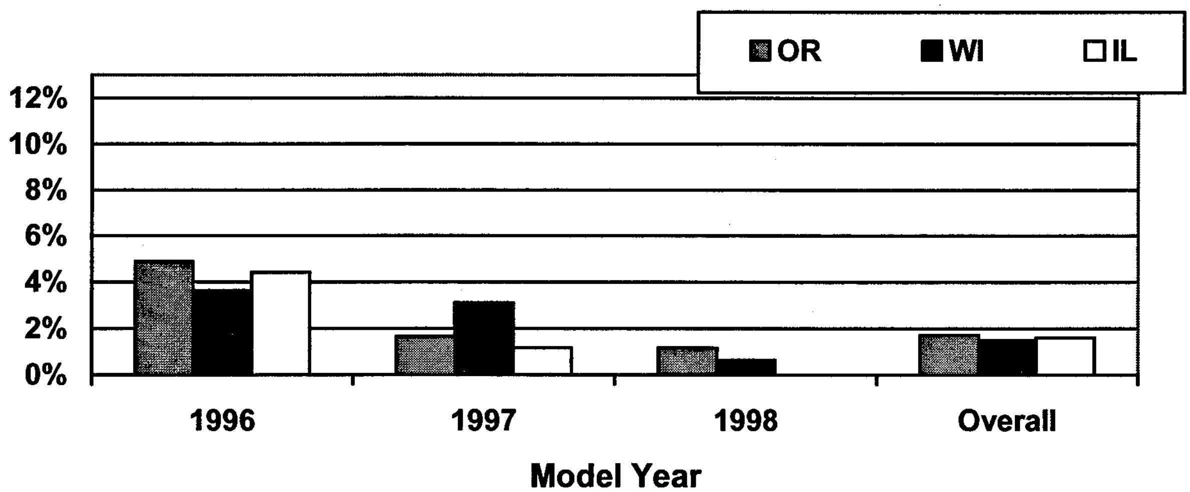


Figure A-4
Percent of Vehicles with Catalyst Not Ready

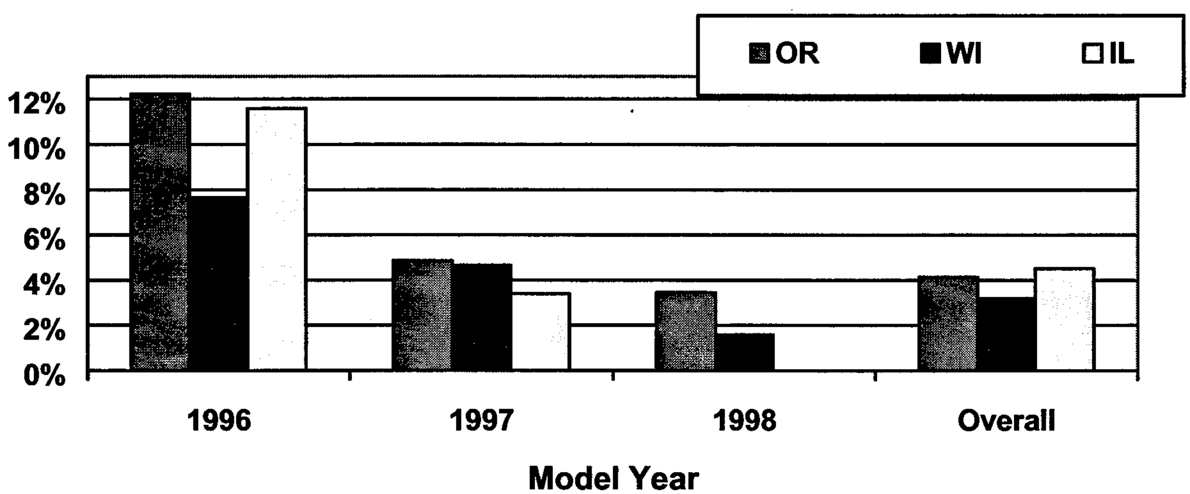


Figure A-5
Percent of Vehicles with Evap Not Ready

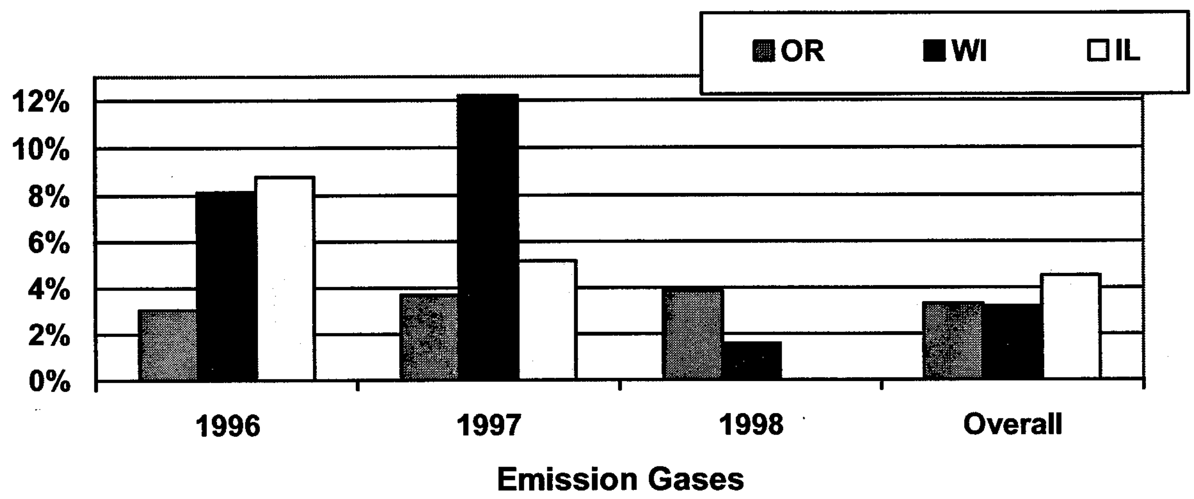
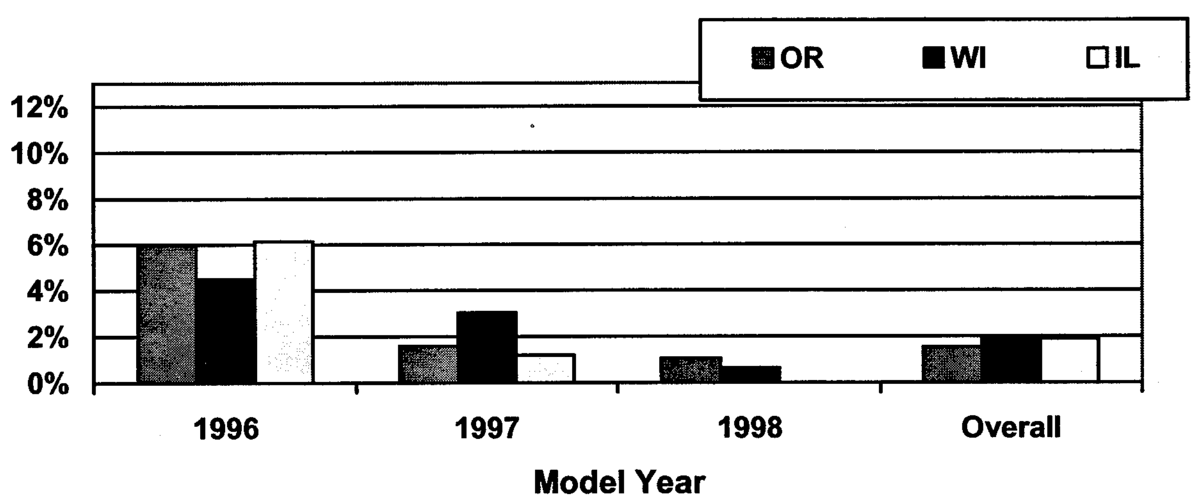


Figure A-6
Percent of Vehicles with EGR Not Ready



ADDITIONAL STATISTICS ON DIAGNOSTIC TROUBLE CODES (DTCs)

dKC tabulated the top 10 DTCs among vehicles with illuminated MILs (Table A-1). dKC also tabulated the top 10 DTCs from all vehicles including those that did not have illuminated MILs (Table A-2). DTCs from vehicles that do not have illuminated MILs represent either pending codes (the problem has been identified but has not been observed twice in a row) or history codes (the problem has gone away and the system turned the MIL off by itself). The top 10 DTCs among vehicles with illuminated MILs is very similar to the overall tabulation of DTCs except for one code, P0711. This code is for transmission fluid temperature out of range. There were 157 observances of this code among vehicles with MILs that were not illuminated and no observances of this code among vehicles with illuminated MILs. Apparently the auto manufacturers use this code as a diagnostic but do not set a MIL when the problem occurs.

Table A-1
Wisconsin's Top 10 DTCs – Vehicles with MILs Commanded-On

DTC	#	Interpretation
P0401	131	EGR Flow Insufficient
P0133	120	O2 Sensor Slow Response
P1443	89	Ford Evap Control Valve Failure
P0420	88	Low Catalyst Efficiency
P0440	74	Evap Malfunction
P0171	52	System too lean -- Bank 1
P0141	46	O2 Sensor Heater Circuit
P0442	44	Small evap leak
P0300	43	Random Misfire
P0455	40	Gross Evap Leak

Table A-2
Wisconsin's Top 10 DTCs -- All Vehicles

DTC	#	Interpretation
P0133	270	O2 Sensor Slow Response
P0401	162	EGR Flow Insufficient
P0711	157	Trans fluid temp out of range
P0300	152	Random Misfire
P0420	114	Low Catalyst Efficiency
P1443	110	Ford Evap Control Valve Failure
P0440	101	Evap Malfunction
P0153	99	O2 Sensor Slow Response
P1456	93	Evap Fuel Tank Leak
P0171	87	System too lean -- Bank 1

APPENDIX B
REPORTS FROM EPA'S OBDII I/M POLICY FACA GROUP

On-Board Diagnostics (OBD) Policy Workgroup
December, 2001

Charter

A new workgroup under the Mobile Source Technical Review Subcommittee will provide policy advice to the Environmental Protection Agency (EPA) and the States to help facilitate effective implementation of the use of on-board diagnostics in vehicle inspection and maintenance (I/M) programs.

The key goal of this workgroup is to review EPA's I/M and OBD implementation plans, advise EPA on the adequacy of the plans, and assist the Agency in developing additional strategies, where needed, to be responsive to recommendations from the National Academy of Sciences (NAS) report, "Evaluating Vehicle Emissions Inspection and Maintenance Programs." The workgroup is also asked to advise the Agency on addressing other stakeholder issues regarding the use of OBD in I/M programs for 1996 and newer vehicles. These issues include concerns about the potential conflict of interest for manufacturers checking their own vehicles, OBD durability, and changes in failure rates with the transition from I/M to OBD for newer vehicles.

Timeline

The OBD policy workgroup is envisioned to be a short-term effort of approximately six months, with the primary goal of providing the Agency with advice regarding actions the Agency can take to help states to successfully make the transition to the use of OBD. This transition has already begun in some states, and is required by January, 2003, with possible phase-in until 2005.

Workgroup Membership

Brock Nicholson, of North Carolina Department of Environment and Natural Resources, and Lori Stewart, of EPA will co-lead this workgroup. The group will include representatives of states and state associations, environmental groups, I/M consultants, automobile manufacturer representatives, and automobile repair representatives.

On-Board Diagnostics Policy Workgroup
Mobile Sources Technical Review Subcommittee
Clean Air Act Advisory Committee

Minutes of the Workgroup's Meeting on December 11, 2001
Alexandria, Virginia
DRAFT December 27, 2001

Welcome, Introductions, and Review of Agenda

Lori Stewart (EPA), one of the Workgroup co-chairs, called the meeting to order at 10:00 a.m. The purpose of this meeting was to launch the new workgroup. The meeting agenda included a summary of a recent report by the National Research Council (NRC) on inspection and maintenance (I/M) programs, EPA's response to the report, and discussion of issues regarding on-board diagnostics (OBD). Ms. Stewart said that the EPA hopes the Workgroup will be able to provide consensus recommendations on as many issues as possible.

Brock Nicholson (NC DAQ), the other Workgroup co-chair, reviewed the charter that had been drafted for the new workgroup. Several Workgroup members commented that they prefer the word "phase-in" over the word "transition" (from I/M to OBD programs) because I/M programs are not going to be totally replaced by OBD programs. Ms. Stewart expressed willingness to change the language in the charter to reflect these comments (#1).[10]

National Research Council's Report on I/M Programs

John Holmes (NRC) gave the presentation *Evaluating Vehicle Inspection and Maintenance Programs* by NRC's Committee on Vehicle Emission Inspection and Maintenance Programs. He reviewed the Committee's findings. If funded, the Committee will conduct phase 2 of this study, which will look at broader issues related to I/M programs, such as comparing them to other ways of achieving emission reductions from vehicles.

Workgroup members asked whether their discussions would constitute a rebuttal to phase 1 of NRC's study and/or the independent evaluation of OBD testing programs that was recommended by the NRC. Ms. Stewart said that, while no formal decision had been made on those questions, the EPA does not currently have a separate, independent evaluation planned and hopes that this Workgroup and the OBD Technical Workgroup will be useful to the EPA, especially since the Workgroups have new data to evaluate (data which the NRC committee did not have). Greg Green (EPA) added that the EPA hopes that the Workgroup will identify the issues that are most important to the states regarding OBD programs. Mr. Nicholson added that it would be helpful if the Workgroup were to develop recommendations and design approaches for programs that specifically address the concerns raised in the NRC's study.

---

[10] The numbers in parentheses refer to the list of action items appearing below.

Ron Lipinski (MD Dept. of Env.) mentioned a November editorial in *USA Today* which asserted that the NRC study concluded that OBD is not ready to be implemented; he expressed concern that the public may become confused since states need to go ahead with implementation of their OBD programs despite the NRC's recommendations and the editorial. Mr. Holmes responded that the Committee was not supposed to consider policy implications while preparing the report and cannot take positions once the report is published; he added that the report did not say that existing OBD programs should stop. Ms. Stewart said that public outreach should be one of the issues on which the Workgroup focuses its future discussions.

Nancy Seidman (MA Dept. of Env. Protection) said that the two issues of most concern to her state are the small overlap of vehicles failing the OBD and I/M tests, and the effect of high-mileage vehicles (7-12 years old) on the implementation of OBD programs.

David Rivkin (Baker & Hostetler) said that an important issue to consider is durability. At what point in a vehicle's life does OBD testing becomes much less effective at commanding repairs? He said that the policy implication of this issue is that states should not get rid of their existing infrastructures for testing vehicles because tests other than OBD are likely to be more useful later in a vehicle's life. Mr. Rivkin also said that states need to develop implementation strategies that balance technical considerations, such as durability, with political considerations.

John Cabaniss (AIAM) said that cars are becoming "cleaner" due to lower emissions standards, making it more difficult to distinguish "high emitters" from "low emitters" using I/M tests, which might not have the appropriate resolution. Mr. Holmes said that the vehicle fleet is becoming more skewed, with "dirty" vehicles now appearing very dirty because of the lower emission standards. Mr. Cabaniss suggested that OBD II is a much better mechanism than tailpipe testing for finding problems in lower emitting vehicles.

Issues Relating to OBD

Workgroup members were given a chance to state their issues relating to OBD. John Elston (NJ Dept. of Env. Protection) stated that New Jersey is cautious about OBD programs and wants them to be implemented perfectly. He expressed concern over the fact that OBD was originally going to be used as an adjunct to I/M testing, but has recently been viewed as a replacement to I/M exhaust testing. He said that his three biggest issues are: 1) the need to identify criteria for certification of OBD systems, 2) the need for a metric for in-use performance, and 3) enforcement (e.g., penalties).

Rick Barrett (CO Dept. of Health) said that Colorado's biggest need is to be able to defend their OBD program as sensible and cost-effective. He added that the state will need to monitor the effectiveness and cost-effectiveness of their program as vehicles age and be able to justify their program.

Mr. Cabaniss asked for clarification on the problem of manufacturer's conflict of interest. Mr. Elston explained that there is concern that 1) manufacturers will construct lights so that they do not illuminate (e.g., to spare themselves repair expenses while vehicles are under warranty) and 2) dealers will be inspecting the vehicles they sell. He added that carefully constructed sensors could miss a pattern of neglect in the construction of OBD. Jason Grumet (NESCAUM) said that no one is suggesting that manufacturers would intentionally subvert the law, but there is a need for an effective enforcement regime.

Mark Warren (STS; EASE Diagnostics) said that OBDII was implemented in 1996, and the system is working well. He said that states should not expect it to be implemented perfectly. He also said that tailpipe tests and electronic tests (e.g., OBD tests) are completely different and that one should not be used as the "gold standard" for the other. Ms. Seidman agreed with Mr. Warren's comment regarding tailpipe and electronic tests, but added that states need to be able to explain to the public why the tests are not perfectly correlated.

Mr. Lipinski said that the most important issue to him is to make sure that the repair industry is supportive of OBD programs and ready to implement them. Ted Kotsakis (OR Dept. of Env. Quality) said that his state has already implemented an OBD I/M program, and a recent survey of repair facilities in Oregon showed an overwhelming preference for the OBD test versus other tests. Bob Redding (ASA) added that the repair industry needs some outreach materials to distribute to customers because technicians are not always able to communicate clearly to customers regarding OBD performance.

EPA's Response to NRC and Stakeholder Concerns

Ms. Stewart gave the presentation "The Use of On-Board Diagnostics in Inspection and Maintenance Programs: Issues and EPA's Plan." She reviewed issues raised by both the NRC report and stakeholders and discussed EPA's planned actions relating to each issue.

Some Workgroup members expressed a desire to continue the Workgroup's activity after the 6-month time frame specified in its charter. Ms. Stewart said that EPA wanted some initial consensus recommendations in the 6-month time frame because some states will begin implementing their OBD programs soon. Mr. Nicholson said that the Workgroup can be more open-minded about extending the time frame, and Ms. Stewart suggested that the Workgroup could establish 6-month goals and develop a list of longer-term issues. Mr. Elston stressed that the Workgroup's recommendations should be focused rather than broad.

Mr. Kotsakis reported on the results of Oregon's OBD program. He said that, when cars are maintained from the beginning of their life based on OBD test results, they have lower emissions and lower repair costs. He also said that vehicle owners will not repair their vehicles based on OBD test results unless they are required to do so.

Update from OBD Technical Workgroup

Ed Gardetto (EPA) gave the presentation "OBD Technical Workgroup Status." He updated the Workgroup on the activity of the OBD Technical Workgroup. He also presented some of the Workgroup's general observations based on existing data. Mr. Gardetto said that the real purpose of I/M programs is to fix "dirty" vehicles so as to lower their emissions. Mr. Elston countered that the key to getting "dirty" vehicles fixed is to identify them through an I/M program.

Mr. Elston asked whether the EPA intends to develop a list of approved scan tools for OBD programs. When Mr. Gardetto replied that the EPA is not sure whether it will develop guidance or set standards for scan tools, Mr. Elston replied that states would find it helpful to know which scan tools are not approved. Mr. Elston also inquired about the new protocol [CAN?] being developed on model year 2003 vehicles for communication between OBD systems and scan tools. Mr. Gardetto replied that scan tools will need to be upgraded to be compatible once the new protocol is approved.

Mr. Lipinski asked whether the EPA and states have seen patterns in the "dirty" vehicles that are not identified as such by OBD testing. Mr. Gardetto and Mike McCarthy (CARB) replied that some manufacturers did not design OBD systems that completely conform to requirements. Mr. Lipinski further inquired as to whether the EPA and states have seen any evidence of tampering by consumers. Mr. Kotsakis said Oregon has not seen anything that looked intentional. Mr. Gardetto said he has seen isolated incidents of consumers creatively attempting to get around OBD failures. Mr. McCarthy described creative attempts by California taxi cab drivers to get around OBD failures by tampering with their OBD systems.

Ms. Seidman asked whether Mr. Gardetto had any documentation of the EPA's ongoing high-mileage study. Mr. Gardetto agreed to provide a short description of the study and results (#2).

Oregon's OBD Program

Mr. Kotsakis was given time to further elaborate on Oregon's experience with their OBD program. He said that the program has been successful. None of the issues that have come up at this meeting posed major problems for Oregon, although they did encounter some obstacles along the way, such as confusing terminology for the technicians performing the tests and teaching the technicians where the data link connectors are located. Oregon concentrated on keeping the program simple by not exempting specific models, and "sold" the program to the state legislature as a quicker method with cheaper infrastructure that motivates preventative maintenance. The failure rates and repair costs are very close to those rates and costs under the previous testing method (BAR 31). Of the vehicles that are sent away for being not ready, 98 percent return ready the second time, and greater than 99 percent return ready the third time. Overall, Oregon's experience with the OBD program has been very positive, and the public's experience also has been positive.

Conclusion and Next Steps

Ms. Stewart restated the issues that she heard raised at this meeting.

1. Pollution prevention (preventative maintenance).
2. Failure rates (Is it problematic to fail vehicles at 1.5 times the emission standard?).
3. Public's perception of lack of overlap of failures between different tests.
4. Manufacturer's conflict of interest.
5. Durability of OBD systems.
6. Outreach efforts to the public and the repair industry.

Ms. Seidman asked about the high-mileage study and Ms. Stewart replied that it is covered under issues #1, 2, and 5. Mr. Warren said that the availability of manufacturer information is an important issue for the repair industry, especially for making repairability more cost-effective. There were several further comments regarding the need for outreach to both consumers and the repair industry.

The Workgroup discussed which issues to address at the next meeting, which will be held on Tuesday, February 12, in Alexandria, Virginia (#3). The Workgroup put the following topics on the agenda for the next meeting.

$ Certification and conflict of interest (suggested presenters: Arvon Mitcham (EPA), Dan Harrison (EPA), and Mike McCarthy (CARB)).
$ Pollution prevention.
$ Failure rates

Ms. Stewart encouraged Workgroup members to think about what the Workgroups's final product should be and said that the Workgroup would discuss that at the next meeting (#4). Mr. Lipinski said that other issues may arise before the next meeting as states begin implementing their OBD programs and asked the co-chairs to be flexible in allowing time for these issues at the next meeting.

Mr. Elston said that the EPA and the Workgroup need to be open to discussing issues rather than just trying to diffuse issues. Mr. Nicholson encouraged Mr. Elston and others to advise the Workgroup on issues it should discuss. Mr. Elston requested that the co-chairs post the issues discussed at this meeting on a Website and give the Workgroup members a chance to comment on them. Ms. Stewart said that the Workgroup could communicate about the list of issues via email, rather than a public Website. Mr. Nicholson encouraged Workgroup members to provide feedback to the co-chairs after this meeting (#5).

Action Items

1. The co-chairs will revise the charter to reflect comments made at the meeting.
2. Mr. Gardetto will provide Workgroup members with a short description of the EPA's high-mileage study.

3. The Workgroup will hold its next meeting on Tuesday, February 12, in Alexandria, Virginia.
4. Workgroup members will develop recommendations for the form of the Workgroup's final product and discuss them at the next meeting.
5. Workgroup members will provide feedback to the co-chairs and the Workgroup on the list of issues generated during the December meeting.

On-Board Diagnostics Policy Workgroup
Mobile Sources Technical Review Subcommittee
Clean Air Act Advisory Committee

Minutes of the Workgroup's Meeting on February 12, 2002
Alexandria, Virginia
DRAFT February 21, 2002

Welcome, Introductions, and Review of Agenda

Lori Stewart (EPA), one of the Workgroup co-chairs, called the meeting to order at 10:00 a.m. The purpose of this meeting was to learn more about particular aspects of on-board diagnostics (OBD) and discuss the group's position on these issues. The meeting agenda included the following issues: certification and in-use testing, warranties/durability, lack of overlap of OBD and I/M failures, hardware and software issues, and outreach/education. Brock Nicholson (NC DAQ), the other Workgroup co-chair, stated that the intent of the Workgroup was to give stakeholders an opportunity to express all of their issues related to OBD and spend some time addressing the concerns.

Ms. Stewart stated that the Public Interest Research Group would not be able to participate in the Workgroup, but the American Lung Association (ALA) would participate in future meetings. Since the ALA was not able to participate in this meeting, the organization sent a letter expressing their concern that the Workgroup appeared to be treating conflict of interest as a compliance issue only rather than as a central issue to OBD policy. Ms. Stewart stated that conflict of interest is intended to be a major topic of discussion at this meeting.

OBD Certification and In-Use Testing

Dan Harrison (EPA) and Mike McCarthy (CARB) gave the presentations "OBD and Vehicle Emission Compliance Programs" and "Assuring Compliance with Emission Standards," respectively, regarding the EPA's and California's programs for certification and in-use testing of OBD systems. Attachment 1 provides a breakdown of the reasons for the 2.2 million recalls in California in 2000.

Several Workgroup members asked whether the warranty data that are reported to California is publicly available. Mr. McCarthy replied that the data are considered confidential and are not made available to the public, although California does share the data with the U.S. EPA. He added that some of the warranty data would be made available to service technicians in the future. Mr. Harrison noted that the defect reports that manufacturers submit to the EPA are not confidential. Nancy Seidman (MA DEP) suggested that the states combine their data from OBD I/M programs into a national database that would help states and the EPA identify problems more quickly. Ed Gardetto (EPA) stated that a national database containing data from all the states is unnecessary because the EPA can recognize patterns and identify problems using a relatively small data set; he added that states do not like mandatory reporting requirements, although they are welcome to voluntarily submit data to the EPA.

John Cabaniss (AIAM) encouraged states to focus on how to achieve better recall compliance rates, citing California's policy of linking re-registration with recall compliance as an example of a way to do so. John Elston (NJ DEP) stated that states need help integrating OBD into their existing I/M programs and philosophies, and recommended that a plan be developed for better sharing with the states the results of EPA's investigations of OBD. He also expressed his concern over the confidentiality of OBD data that could be helpful to the states. Finally, he urged states to incorporate a plan for very old cars in their OBD programs because program effectiveness depends upon [proper diagnosis of?] such vehicles.

Conflict of Interest

The Workgroup members briefly discussed the issue of conflict of interest. Mr. Elston explained that the issue is that auto manufacturers are designing, installing, testing, and inspecting their own systems and could have incentives to perform any of these activities improperly. David Rivkin (Baker & Hostetler) added that people who have a vested interest in the outcome of a test should not be performing the test. Mr. Nicholson emphasized that it is a perceived problem with OBD, but he is confident that there are checks and balances in place to prevent dishonesty on the part of manufacturers. Frank Krich (DaimlerChrysler) stated that the threat of recall is a significant deterrent and stressed that people need to be educated about the checks and balances that are in place, such as in-use testing.

Mr. Nicholson proposed that the Workgroup form a task force of 5 to 6 people to focus on the issue of conflict of interest. He suggested that the task force be composed of the following members: Mr. Elston, Mr. McCarthy, Ms. Seidman, Mr. Rivkin, Cass Andary (Alliance of Automobile Manufacturers), and a representative from the American Lung Association. Mr. Andary volunteered to be the chair of the task force. Mr. Nicholson charged the task force with identifying sub-issues that should be addressed by the Workgroup, drawing conclusions regarding the status of these sub-issues, and forming recommendations for addressing the sub-issues (#1). He requested that the task force produce a short and simple document to present to the full Workgroup for review and discussion. Art Williams (ALAPCO) suggested that one of the sub-issues the task force should consider is how to get useful information regarding OBD systems, such as defect reports and warranty reports, to the public quickly so that they can make wise decisions regarding vehicles. He also recommended consideration of the related issue of how to get faster linkages of data between state and local I/M programs.

OBD Warranties and Durability

Arvon Mitcham (EPA) discussed the handout "OBD Warranties/Durability" which described the Clean Air Act requirements for warranty periods for light-duty vehicles.

Mr. Elston asked if the Workgroup could view a blank defect report form in order to understand the kind of information that is reported to the EPA when a manufacturer discovers more than 25 defects in a specific part. Mr. Harrison replied that there is no specific format for defect reports, although there are required elements.

Lack of Overlap Issue

Mr. Gardetto gave the presentation "OBD and I/M Failures" in which he presented data related to the issue of the lack of overlap between OBD and I/M tailpipe test failures. Workgroup members were also given a draft "message" regarding the lack of overlap issue.

Workgroup members pointed out that the lack of overlap between OBD and I/M failures should decrease in the future. Several people noted that the lack of overlap should decrease as the fleet ages both because there will be a larger sample size and because vehicles become dirtier as they age. Vince Mow (Waekon Corp.) noted that model year 1996 through 1998 vehicles were the first vehicles to contain OBD systems and naturally have flaws that have since been corrected.

Mr. Rivkin expressed concern over the finding that OBD programs identify preventative maintenance measures for vehicles that meet emission limits while sometimes failing to identify, and therefore fix, vehicles that do not meet emission limits. Mr. Gardetto stated that the I/M tailpipe test also misses some "dirty" vehicles and that no test is perfect, but the OBD test is best for the vehicles that are currently being produced and is being improved as more data are collected. Another Workgroup member added that OBD is better than I/M240 programs for ensuring that vehicles are properly repaired after they fail the test, which is equally as important as whether a test correctly identifies "dirty" vehicles.

Rick Barrett (CO Dept. of Health) suggested that the Workgroup add an acknowledgment of the fact that OBD misses some "dirty" vehicles to the draft "message" regarding the lack of overlap. He stressed that the problems related to the lack of overlap are not going to be solved immediately, so stakeholders should remain vigilant about them while continuing to conduct studies of OBD programs. As Mr. Cabaniss pointed out, until more data become available, it will not be possible to know all of the reasons for the lack of overlap. Ms. Stewart suggested that resources would be better spent on looking toward the future and trying to maximize the usefulness of the OBD program than on trying to determine all of the many factors that contribute to the lack of overlap. In general, most of the Workgroup members seemed to agree that the lack of overlap is not a "show-stopper" for OBD.

OBD Hardware and Software Issues

Charlie Gorman (ETI) and Mr. Mitcham gave the presentation "OBD Hardware/Software Issues" in which they discussed areas of concern related to OBD communication protocols and vehicle and equipment compatibility. Mr. Mitcham also discussed the protocol verification tool or "golden scan tool" that the EPA is developing to verify that OBD systems are compatible with scan tool protocols. He stated that states could potentially use the tool as a means of periodically auditing garages to ensure that their scan tools are working properly. The vehicle scanning audit that the EPA has proposed to develop is more useful for up-front audits of scan tools.

Mr. Elston expressed the desire of state air managers to have a list of specifications for scan tools that are officially approved by the EPA so that they can purchase appropriate equipment for their OBD lanes. Mr. Gorman stated that states already have available to them the SAE specifications for scan tools as well as test sequences that have been developed by states. He recommended that the EPA make available to states a list of issues concerning communication between OBD systems and scan tools that have arisen as states have implemented their OBD programs. Mr. Mitcham said that he could produce such a list soon and distribute it to the Workgroup (#2).

Several sub-issues related to OBD hardware and software were recommended as points of discussion for future Workgroup meeting: 1) whether scan tools are standardized, and 2) whether the possibility exists for people to electronically tamper with OBD systems.

Update on OBD Outreach Efforts

Sally Newstead (EPA) gave the presentation "OBD Communication and Outreach" in which she provided an update on the outreach activities that the EPA is conducting in order to inform the appropriate people about OBD systems.

Several Workgroup members reported success in outreach efforts through such means as: educating children, training technicians in automotive schools, and requiring mandatory training of technicians. Bob Redding (ASA) stated that the key to successful outreach for OBD is targeting a simple and accurate message to the appropriate audience. The Workgroup discussed the need to ensure that communication efforts target service writers with the appropriate message to convey to their customers (the public), and target technicians with accurate information regarding proper diagnoses and associated repairs.

Conclusion and Next Steps

Ms. Stewart stated that resource constraints would limit the number of face-to-face meetings this Workgroup could hold and proposed holding monthly 2-hour conference calls (#3) between now and the next Mobile Sources Technical Review Subcommittee meeting in June, when the Workgroup could get together again for a face-to-face meeting. The Workgroup approved this idea and agreed to arrange dates and topics for the conference calls via electronic mail. The Workgroup also agreed to continue discussing the "lack of overlap" issue via electronic mail in order to develop the group's position on the issue (#4).

The meeting concluded at 3:00 p.m.

Action Items

1. The newly-formed "Conflict of Interest" Task Force will identify sub-issues to be addressed, draw conclusions regarding the status of the sub-issues, and make recommendations for addressing the sub-issues.
2. Arvon Mitcham (EPA) will provide the Workgroup with a list of issues that states have encountered regarding communication between OBD systems and scan tools.
3. The Workgroup will hold monthly 2-hour conference calls on dates to be determined.
4. The Workgroup will discuss the "lack of overlap" issue via electronic mail and develop the group's position on the issue.

Attendees

David Amlin	California Bureau of Automotive Repair	david_amlin@dca.ca.gov	916-255-1376
Cass Andary	Alliance of Automobile Manufacturers	candary@autoalliance.org	248-357-4717
Matt Astleford	U.S. EPA	astlmat@buu.edu	202-564-7478
Rick Barrett	CO Dept. of Health	rick.barrett@state.co.us	303-692-3123
Darrin Bartram	Baker & Hostetler	dbartram@bakerlaw.com	202-861-1735
Donna Boysen	MJ Bradley & Associates	dboysen@mjbradley.com	978-369-5533
Robert Brown	Ford Motor Co.	rborwn8@ford.com	313-322-3198
John Cabaniss	Association of International Automobile Manufacturers (AIAM); NASTF	jcabaniss@aiam.org	703-247-2107
Ann Deering	EC/R Inc. (EPA contractor)	deering.ann@ecrweb.com	919-484-0222x331
Tom Durbin*	UC Riverside	durbin@cert.ucr.edu	909-781-5794
John Elston	NJ Dept. of Environmental Protection	jelston@dep.state.nj.us	
David Ferris	General Motors	david.h.ferris@gm.com	248-857-1967
David Filbert	MD Dept. of the Environment	dfilbert@mde.state.md.us	410-631-4131
Michael Fitzgerald	NH Dept. of Environmental Services	mfitzgerald@des.state.nh.us	603-271-6390
Jerry Gallagher	J. Gallagher & Associates	jlgallagher@uswest.net	720-528-1415
Ed Gardetto	U.S. EPA	gardetto.edward@epa.gov	734-214-4322
Charlie Gorman	Equipment & Tool Institute (ETI)	cgorman@etools.org	815-943-3810
Dan Harrison	U.S. EPA	harrison.dan@epa.gov	734-214-4281
Yoshiaki Higuchi	Mitsubishi	yhiguchi@cl.mrda.com	714-372-9565
Megan Hoert	EC/R Inc. (EPA contractor)	hoert.megan@ecrweb.com	919-933-9501x244
Ross Jenkins	Parsons	rjenkins@protectair.com	405-944-8877
Khesha Jennings	U.S. EPA	jennings.khesha@epa.gov	202-564-9302
Yoshihiro Kawaguchi	Mitsubishi	ykawaguchi@mitfuso.com	856-467-3973
Rob Klausmeier	de la Torre Klausmeier Consulting	delaklaus@aol.com	512-447-3077
Ted Kotsakis	OR Dept. of Environmental Quality	kotsakis.ted@deq.state.or.us	503-731-3050x231
Frank Krich	DaimlerChrysler	fak6@dcx.com	248-576-5497
Doug Lawson	National Renewable Energy Lab	doug_lawson@nrel.gov	303-275-4429
Michael Lord	Toyota Technical Center	lord@ttc-usa.com	310-787-5644
Mike McCarthy	CA Air Resources Board	mmccarth@arb.ca.gov	626-575-6615
Peter McClintock	Applied Analysis	petermcc@pacbell.net	415-435-8301
Arvon Mitcham	U.S. EPA	mitcham.arvon@epa.gov	734-214-4522
Dennis Morgan	MD Dept. of the Environment	dmorgan@mde.state.md.us	410-631-3416

Vince Mow	Waekon Corp.	vincem@waekon.com	410-648-9911
Sally Newstead	U.S. EPA	newstead.sally@epa.gov	734-214-4474
Brock Nicholson	NC Division of Air Quality	brock.nicholson@ncmail.net	919-715-0587
Masahiko Nomura	Mitsubishi	mnomura@mrda.com	734-477-6120
Chris Plaushin	AAA	cplaushin@national.aaa.com	202-942-2072
Vincent Porcaro	Parsons	vincent.porcaro@parsons.com	609-620-4889
Bob Redding	Automotive Service Association (ASA)	b.redding@worldnet.att.net	202-543-1440
David Rivkin	Baker & Hostetler	drivkin@bakerlaw.com	202-861-1731
Keisuke Sano	Toyota Technical Center	kei@ttc-usa.com	734-995-3753
Nancy Seidman	MA Dept. of Environmental Protection	nancy.seidman@state.ma.us	617-556-1020
Peter Spencer	House Energy & Commerce Committee	peter.spencer@mail.house.gov	202-225-5736
Lori Stewart	U.S. EPA	stewart.lori@epa.gov	202-514-1104
Keiichiro Sugimoto	Toyota Technical Center	sugimoto@ttc-usa.com	734-995-3767
John Trajnowski	Ford Motor Co.	jtrajnow@ford.com	313-322-5670
Suanne Thomas	Volkswagen	suanne.thomas@vw.com	248-754-4706
Andy Vaichekauskas	Mitsubishi	av@wdc.mrda.com	703-525-4800x226
John VanGilder	General Motors	john.vangilder@gm.com	248-685-5845
Art Williams	ALAPCO; Air Pollution Control District of Jefferson County, KY	awilliams@co.jefferson.ky.us	502-574-8689
Hal Zatorski	DaimlerChrysler	hz2@daimlerchrysler.com	248-576-5006

* participated via phone

APPENDIX C
STATE I/M CONTACTS

ARIZONA – Dan Grubbe, AZ DEQ 602-207-7012

BRITISH COLUMBIA (BC) – Martin Lay – President, Translink Corp – 604-775-0095

CALIFORNIA – Dave Amlin – BAR – 916-255-1376

COLORADO – Rick Barrett, CO Dept of Health – 303-692-3123.

CONNECTICUT – Bob Waz – CT DMV – 203-805-6224

FLORIDA – Dwight Davis – FL Dept of Public Safety – 850-488-1102

GEORGIA – Kent Pierce – GA DNR – 404-363-7031

ILLINOIS – Betsy Tracy – IL EPA – 217-782-0408

INDIANA – Michael Worrell – IN Dept of Environmental Management – 317-232-8218

KENTUCKY – Ron Hall, Jefferson County, 502-458-1018.

MAINE – Scott Wilson – ME DEP 207-287-2437

MARYLAND – Ron Lipinsky – MD Dept of Environment – 410-631-3270

NORTH CAROLINA – Paul Gordey – NC DAQ – 919-715-7220

NEW HAMPSHIRE – Becky Ohler – NH DES – 603-271-6747

NEW YORK – Guy Bobersky – NY DEC – 518-457-8894

OHIO – Andrea Stevenson – Ohio EPA – 614-644-3059

OREGON – Jerry Coffer – OR DEQ – 503-731-3050 (ext. 229)

PENNSYLVANIA – Peter Gertz – PA DOT – 717-783-7016

TENNESSEE (NASHVILLE) – Harry Dugan – 615-299-9430

TEXAS – Bob Wierzowiecki – TNRCC – 512-230-1769

UTAH – Salt Lake County – Jim Brande – 801-313-6677

VERMONT – Tom Moye – 802-241-3819

VIRGINIA – Rich Olin – VA DEQ – 804-698-4425

WASHINGTON – John Raymond – Dept of Ecology – 360-407-6856

Attachment A

TECHNICAL NOTE

SMOG CHECK STATION PERFORMANCE ANALYSIS
Based On Roadside Test Results

Prepared by:

Rob Klausmeier
dKC

Sandeep Kishan
Andrew Burnette
Meredith Weatherby
Eastern Research Group

Prepared for:

California Bureau of Automotive Repair
Engineering and Research Branch

June 27, 2000

1.0 INTRODUCTION AND SUMMARY

The most important elements of an inspection/maintenance (I/M) program are the identification and effective repair of vehicles with tampered, defective or worn-out emission control systems. In order for an I/M program to achieve maximum benefits, all stations must perform accurate and complete emission tests before and after repairs. The performance of individual stations is a critical issue that must be addressed in a comprehensive evaluation of an I/M program.

With support from Eastern Research Group (ERG), de la Torre Klausmeier Consulting (dKC) assessed the performance of different categories of inspection stations in California. The analysis uses data collected from roadside tests performed between February 1997 and October 1999. These data were collected by the California Bureau of Automotive Repair (BAR). With assistance from the California Highway Patrol, BAR pulls in-use vehicles over and performs an Acceleration Simulation Mode (ASM) test, as well as a limited functional and visual inspection when time permits. Inspections are conducted by state inspectors, and therefore provide an independent measure of the emission readings and the condition of vehicular smog equipment for California's vehicle fleet. Data from these tests help us assess the effectiveness of different types of inspection stations in California's I/M program, referred to as the Enhanced Smog Check Program.

This analysis looks at the differences in reductions achieved for vehicles that are certified at Test-Only and Test-and-Repair stations. In addition, reductions achieved at good performing vs. poor performing Test-and-Repair stations are analyzed. A key feature of the Enhanced Smog Check Program is the hybrid network, which uses two types of licensed inspection stations: Test-Only and Test-and-Repair. Test-Only stations can only perform inspections; they cannot repair vehicles. In California's hybrid network, vehicles with the highest probability of failure are directed to Test-Only stations in the state's enhanced program areas. About 50% of the vehicles tested at Test-Only are directed[1]; the rest come on their own accord.

The analysis is limited to vehicles receiving BAR-97 ASM tests in enhanced program areas before or after the roadside test. The analysis concentrates on the difference between Test-Only and Test-and-Repair stations, since it was easiest to classify Smog Check stations using this breakdown. The Test-and-Repair stations are further classified into different groups according to reported Smog Check statistics, in a preliminary attempt at separating high performing stations from low performing stations.

The following are some of the measures that can be used to compare the performance Smog Check stations:

- Observed emission reductions.
- Reported failure rates for vehicles that have high emissions in roadside tests prior to their Smog Checks.
- Roadside emission rates for vehicles that passed Smog Checks prior to roadside tests.

[1] 43.3% of the vehicles tested at Test-Only facilities are directed high emitters; 6.2% are selected and directed as part of a random sample.

- Percentages of high emitting vehicles after Smog Check.

This report assesses the performance of Smog Check stations using these and other metrics.

Major Findings

Following are the major findings of the analysis of station performance:

- Much greater exhaust emission reductions were observed for vehicles certified at Test-Only facilities than Test-and-Repair facilities. The total sample inspected at Test-Only stations as well as the sample of vehicles failing the test showed greater reductions than the Test-and-Repair sample.

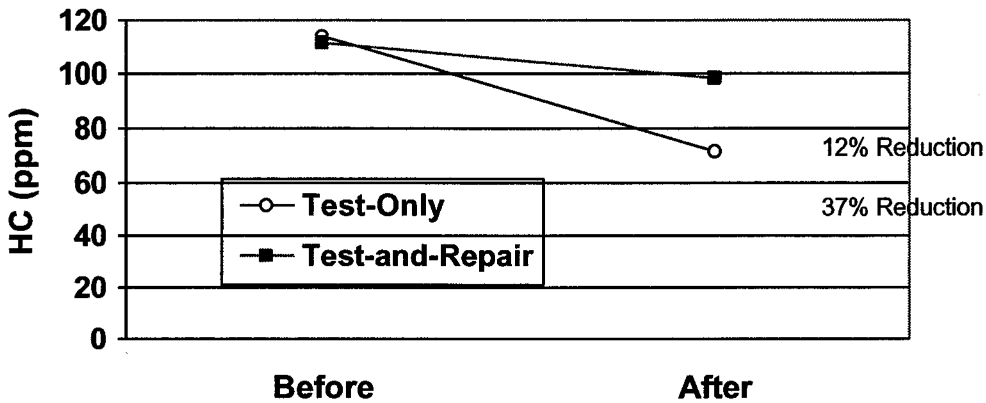
  Figure 1 shows emissions before and after repair by station type. This figure shows data on 1980 to 1986 vehicles. Vehicles within this group are not significantly impacted by BAR's policy of directing high emitters to Test-Only stations. As shown, vehicles certified at Test-Only stations have much lower after Smog Check emission levels, while their before Smog Check levels were almost identical to the Test-and-Repair category.

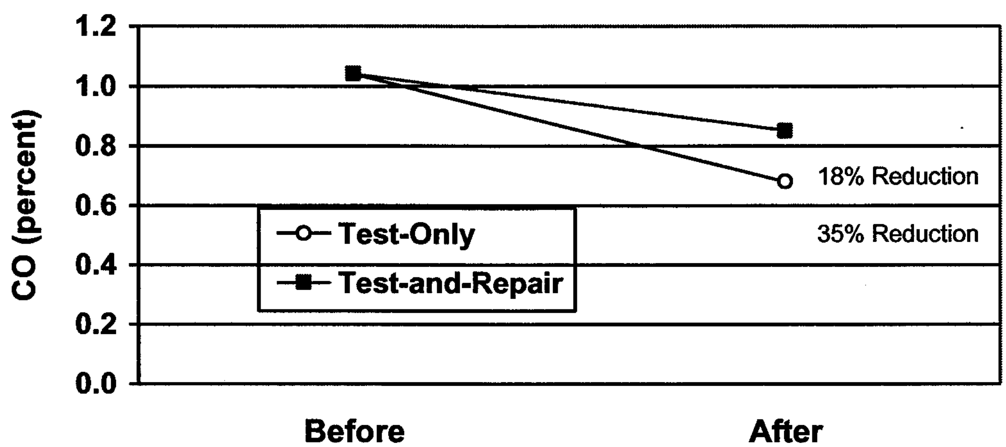
***Recommendation** – BAR should increase the percentage of high emitters directed to Test-Only facilities. Currently, BAR directs 15% of the vehicles with the highest probability of failure to Test-Only facilities. The SIP emission reductions are based on the assumption that 40% of the vehicles with the highest probability of failure are directed to Test-Only stations.*

- By analyzing Smog Check data, BAR has been able to develop performance standards for Test-and-Repair stations. The most promising performance standard is one that ranks stations according to their reported failure rates. Vehicles that were certified in stations that ranked in the top 25% of Test-and-Repair stations (based on reported failure rates) had similar after Smog Check emission levels and showed similar emission reductions to those certified by Test-Only facilities. This standard could be used as a requirement for Gross Polluter Certification (GPC) stations. About 19% of the vehicles in Enhanced areas were certified in the top 25% of Test-and-Repair stations. (About 20% were certified at Test-Only stations.) Currently, about 4% of the fleet is being certified at GPC stations.

  It takes a lot of time and money for BAR to "catch" poor performing stations and take legal action. Furthermore, having a large variation in station performance allows motorists that want to avoid repairs to seek out poor performing stations. The top 25% of the Test-and-Repair stations were observed to reduce ASM 2525 HC emissions by 44% while no reductions were observed for the bottom 25% (Figure 2). Inspections by the top 25% of the Test-and-Repair stations certainly must be much more cost-effective than inspections by the bottom 25%. It might be much more effective for BAR to set performance standards based on program statistics that stations have to meet. If BAR were to establish performance standards that resulted in all Test-and-Repair stations having the same performance as Test-Only stations, Smog Check benefits would increase by more than 50%. Establishing these performance standards would lower the cost per ton of pollutant removed.

FIGURE 1
Comparison of Emission Levels





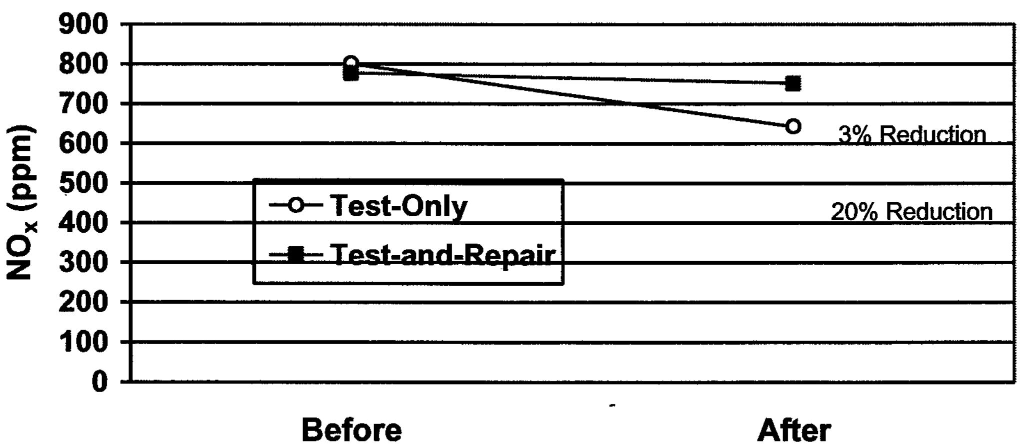
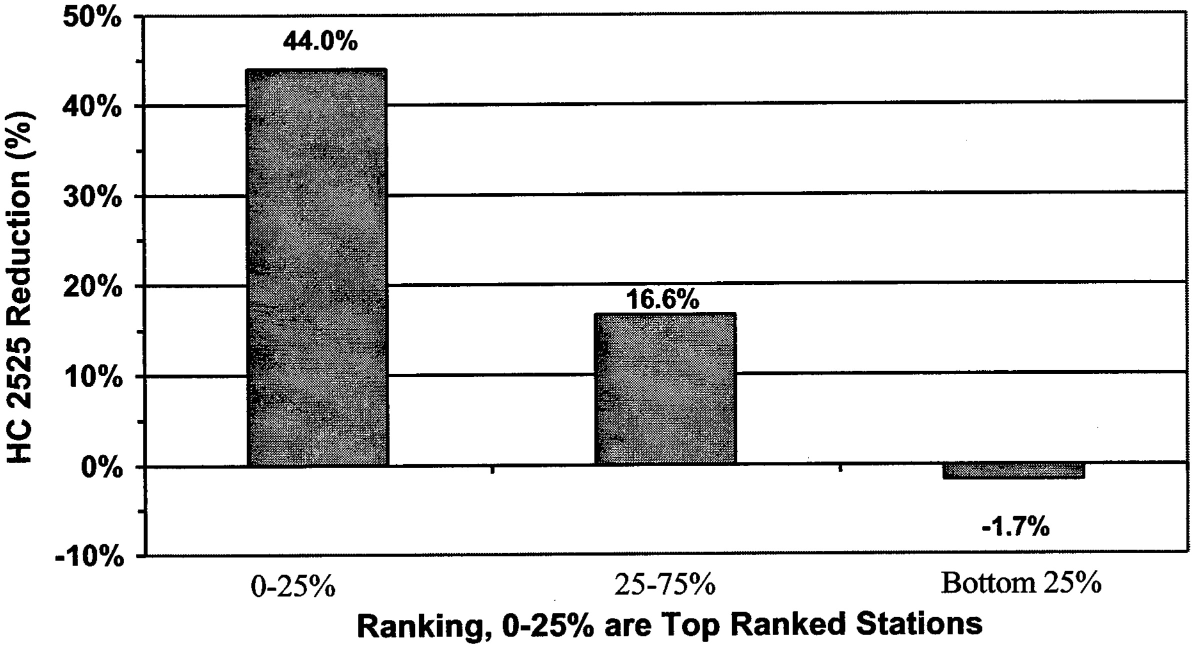


FIGURE 2
Comparison of Observed HC Emission Reductions for Test-and-Repair Stations (1980 to 1991 Model Year Vehicles)



This figure compares observed reductions in HC 2525 emissions for the groups of ranked Test-and-Repair stations. The highest ranked groups had the greatest HC emission reductions. The top 25% had observed reductions of 44% compared to no reductions for the bottom 25%.

Recommendation *– As an alternative to increasing the percentage of vehicles directed to Test-Only stations, BAR could establish performance parameters for Test-and-Repair stations to ensure they achieve the same performance as Test-Only stations. Currently the top 25% of the Test-and-Repair stations based on their reported failure rates have equivalent performance to Test-Only stations. Additional triggers are needed to better weed-out the good Test-and-Repair and Test-Only stations from the bad and increase the percentage high performing stations.*

- Gas cap fail rates were reduced by 65% by the Smog Check program. Furthermore, the reductions were the same for Test-Only and Test-and-Repair stations.

Recommendation *– Smog Check stations should continue to perform gas cap pressure tests, as it provides substantial HC emission reductions.*

Report Organization

The following section discusses the observed exhaust emission reductions by station type. Reasons for differences between the Test-Only and Test-and-Repair results are explored in Section 3. The performance of Test-and-Repair stations that are ranked according to the ratio of reported vs. expected failure rates is discussed in Section 4. The observed reductions in the incidence of gas cap failures by station type are presented in Section 5. Section 6 presents estimated fleet emission reductions in tons per day for Test-Only and Test-and-Repair inspection networks. Appendix A presents details on the methodology used to create and analyze the roadside data set.

2.0 OBSERVED EMISSION REDUCTIONS BY STATION TYPE

The performance of Test-Only versus Test-and-Repair stations can be compared in terms of the observed emission reductions. Percent reductions based on roadside emission levels before and after the station Smog Check inspection can be calculated for both station types.

2.1 Observed Impact of the Smog Check Program on ASM Fail Rates During Roadside Tests

The simplest measure of the impact of the Smog Check Program is how it affects the roadside failure rate. The "roadside failure rate" was calculated using emissions readings obtained during the roadside inspection and BAR's Phase 3 cutpoints. Theoretically, the roadside failure rate should be much lower for vehicles that have already passed Smog Check tests performed at licensed stations than before. Table 1 shows the average failure rate by station type before and after certification in the Smog Check Program. As shown, the Test-Only stations have lower failure rates after Smog Check certification than the Test-and-Repair stations.

TABLE 1
Impact of Smog Check on Roadside Failure Rates

Station Type	Model Year Group	Before Smog Check	After Smog Check	Difference (%)
Test-and-Repair	1974-1979	50.59%	40.00%	20.93%
	1980-1986	44.15%	38.24%	13.39%
	1987-1991	21.92%	16.58%	24.36%
Test-Only	1974-1979	44.44%	34.78%	21.74%
	1980-1986	47.53%	31.35%	34.03%
	1987-1991	24.50%	15.81%	35.46%

This table compares failure rates for the two-mode ASM test using BAR's Phase 3 cutpoints. ASM failure rates in roadside tests conducted after Smog Check certification were lower for the Test-Only sample than the Test-and-Repair sample.

2.2 Fleet Emission Reductions

Table 2 presents average roadside emissions using an ASM test procedure for vehicles before and after they had an Enhanced Smog Check. ASM 5015 and ASM 2525 emissions of hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x) are shown. The *before Smog Check* sample includes all vehicles that had not received an ASM Smog Check prior to their roadside test. The *after Smog Check* sample includes all vehicles that received an ASM Smog Check and were certified prior to their roadside test; it includes vehicles that passed their initial test, or those that failed their initial test and passed after repairs. As shown, the percent reduction observed for Test-Only stations is more than twice as high as the percent reduction observed for Test-and-Repair stations, for all model year groups. Showing results by model year group eliminates much of the bias due to Test-Only stations inspecting targeted high emitting vehicles, since vehicle age is a key parameter in the High Emitter Profile model (the model used to identify likely high emitters).

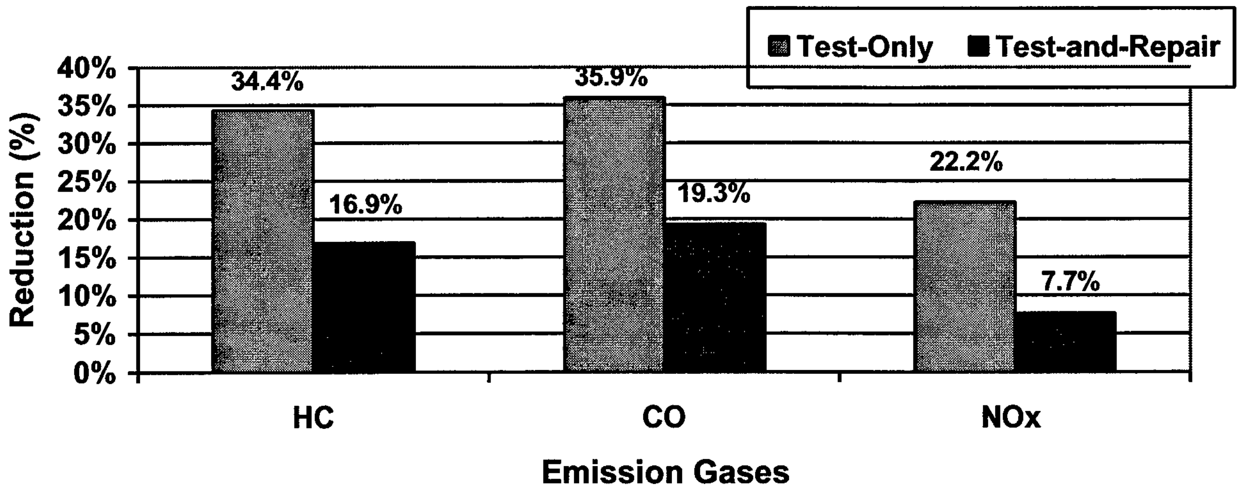
TABLE 2
Average Emission Levels Before and After Smog Check by Station Type

Sequence	Station Type	Model Year Group	N	HC 5015 (ppm)	HC 2525 (ppm)	CO 5015 (%)	CO 2525 (%)	NO 5015 (ppm)	NO 2525 (ppm)
Before Smog Check	Test-Only	1974-1979	108	214.46	211.08	1.21	1.11	887.82	809.84
		1980-1986	869	132.64	113.53	1.11	1.04	895.55	799.96
		1987-1991	302	60.37	52.05	0.45	0.43	566.63	505.16
		ALL*	**1,279**	**107.42**	**95.51**	**0.80**	**0.75**	**734.00**	**657.24**
	Test-and-Repair	1974-1979	340	293.48	278.23	1.43	1.39	1,058.53	941.99
		1980-1986	1,649	127.44	111.53	1.06	1.04	852.50	776.37
		1987-1991	1,788	65.61	55.18	0.42	0.41	543.29	483.89
		ALL*	**3,777**	**117.68**	**104.53**	**0.79**	**0.78**	**726.87**	**653.94**
Sequence	Station Type	Model Year Group	N	HC 5015 (ppm)	HC 2525 (ppm)	CO 5015 (%)	CO 2525 (%)	NO 5015 (ppm)	NO 2525 (ppm)
After Smog Check	Test-Only	1974-1979	50	124.22	116.78	0.80	0.73	909.26	796.24
		1980-1986	386	83.52	71.52	0.71	0.68	746.45	641.25
		1987-1991	216	52.58	42.07	0.28	0.26	389.62	335.91
		ALL*	**652**	**73.42**	**62.71**	**0.51**	**0.48**	**592.26**	**511.23**
	Test-and-Repair	1974-1979	193	198.78	187.26	1.14	1.21	1,053.32	893.74
		1980-1986	981	110.13	98.49	0.89	0.85	833.44	750.98
		1987-1991	1,618	63.92	52.35	0.32	0.30	462.98	413.83
		ALL*	**2,792**	**98.47**	**86.88**	**0.64**	**0.63**	**679.61**	**603.93**
Sequence	Station Type	Model Year Group		HC 5015 (ppm)	HC 2525 (ppm)	CO 5015 (%)	CO 2525 (%)	NO 5015 (ppm)	NO 2525 (ppm)
Percent Reduction	Test-Only	1974-1979		42.08%	44.68%	33.88%	34.23%	-2.41%	1.68%
		1980-1986		37.03%	37.00%	36.04%	34.62%	16.65%	19.84%
		1987-1991		12.90%	19.17%	37.78%	39.53%	31.24%	33.50%
		ALL		**31.65%**	**34.35%**	**36.11%**	**35.92%**	**19.31%**	**22.21%**
	Test-and-Repair	1974-1979		32.27%	32.70%	20.28%	12.95%	0.49%	5.12%
		1980-1986		13.58%	11.69%	16.04%	18.27%	2.24%	3.27%
		1987-1991		2.58%	5.13%	23.81%	26.83%	14.78%	14.48%
		ALL		**16.32%**	**16.88%**	**18.99%**	**19.31%**	**6.50%**	**7.65%**

* Value for "ALL" vehicles determined by weighting themodel year group average emissions by Vehicle Fraction for the average roadside test date (July 1998).

Figure 3 shows the calculated percent reduction in ASM 2525 emissions by station type. This figure shows results for 1974 to 1991 vehicles, weighted by their travel fraction. This figure graphically illustrates the greater emission reductions achieved from vehicles certified at Test-Only stations versus Test-and-Repair stations. ASM 5015 emissions show the same trends.

FIGURE 3
Observed Emission Reductions
Percent Reduction in ASM 2525 Rates by Station Type



This figure compares the observed emission reductions for vehicles tested at Test-Only stations with Test-and-Repair facilities. Results are expressed in terms of percent reduction in ASM 2525 emissions. The sample of vehicles certified at Test-Only stations show much greater emission reductions than the sample certified at Test-and-Repair stations. This data is also shown in TABLE 2.

2.3 Observed Emission Reduction for Failed Vehicles by Station Type

Emission reductions for failed vehicles were calculated by comparing roadside emission levels for vehicles that failed subsequent station Smog Check tests with roadside emission levels for vehicles that were tested after they were failed and repaired. Table 3 presents before and after roadside emission levels for the group of vehicles that failed the ASM test at an official Smog Check station. Results, again, are broken down by Test-Only and Test-and-Repair stations. Overall, the emission reductions observed for vehicles tested at Test-Only stations were about twice as high as those tested at Test-and-Repair stations.

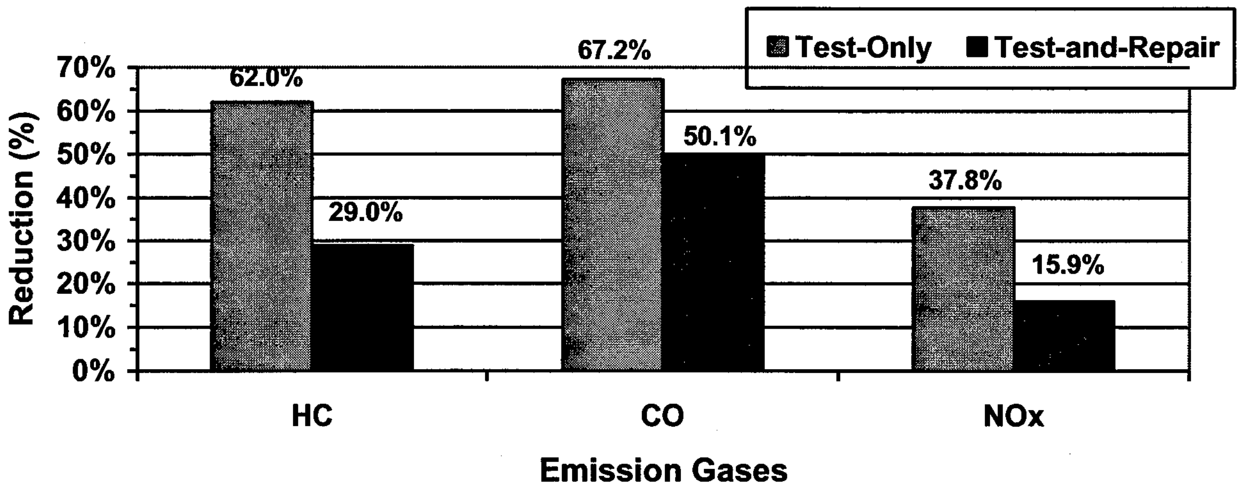
Figure 4 shows calculated percent reductions in ASM 2525 emissions for failed vehicles for the two station types, again, illustrating the greater emission reductions for vehicles certified at Test-Only stations. ASM 5015 emissions show the same trends. The greater reductions for vehicles retested at Test-Only stations can not be explained by the fact that they inspect targeted high emitters, since this analysis is only concerned with reported emission test failures.

TABLE 3
Emission Reduction for Failed Vehicles by Station Type

Sequence	Station Type	Model Year Group	N	HC 5015 (ppm)	HC 2525 (ppm)	CO 5015 (%)	CO 2525 (%)	NO 5015 (ppm)	NO 2525 (ppm)
Before Smog Check	Test-Only	1974-1986	325	241.74	222.98	2.01	1.94	1,109.50	1006.38
		1987-1991	46	130.26	129.89	1.28	1.30	1,113.05	987.38
		ALL*	**371**	**227.92**	**211.44**	**1.92**	**1.86**	**1,109.94**	**1004.02**
	Test-and-Repair	1974-1986	350	187.06	182.57	1.90	1.94	1,058.43	940.55
		1987-1991	168	131.11	116.70	1.06	0.98	1,078.61	970.88
		ALL*	**518**	**168.91**	**161.21**	**1.63**	**1.63**	**1064.97**	**950.39**
Sequence	Station Type	Model Year Group	N	HC 5015 (ppm)	HC 2525 (ppm)	CO 5015 (%)	CO 2525 (%)	NO 5015 (ppm)	NO 2525 (ppm)
After Smog Check	Test-Only	1974-1986	69	96.55	86.84	0.71	0.70	797.13	657.99
		1987-1991	24	87.10	61.78	0.54	0.35	530.60	529.64
		ALL*	**93**	**94.11**	**80.37**	**0.67**	**0.61**	**728.35**	**624.87**
	Test-and-Repair	1974-1986	121	149.68	136.77	1.16	1.09	970.87	875.76
		1987-1991	85	93.89	82.73	0.35	0.42	840.48	689.96
		ALL*	**206**	**126.66**	**114.47**	**0.83**	**0.81**	**917.07**	**799.09**
Sequence	Station Type	Model Year Group		HC 5015 (ppm)	HC 2525 (ppm)	CO 5015 (%)	CO 2525 (%)	NO 5015 (ppm)	NO 2525 (ppm)
Percent Reduction	Test-Only	1974-1986		60.06%	61.05%	64.68%	63.92%	28.15%	34.62%
		1987-1991		33.13%	52.44%	57.81%	73.08%	52.33%	46.36%
		ALL		**58.71%**	**61.99%**	**65.30%**	**67.23%**	**34.38%**	**37.76%**
	Test-and-Repair	1974-1986		19.98%	25.09%	38.95%	43.81%	8.27%	6.89%
		1987-1991		28.39%	29.11%	66.98%	57.14%	22.08%	28.93%
		ALL		**25.02%**	**28.99%**	**49.26%**	**50.05%**	**13.89%**	**15.92%**

* Value for "ALL" vehicles determined by weighting themodel year group average emissions by the sample size (N).

FIGURE 4
Observed Emission Reductions
Percent Reduction in ASM 2525 from Repairs to Failed Vehicles
Test-Only vs. Test-and-Repair



This figure compares the observed emission reductions for vehicles that failed and were retested at Test-Only facilities vs. Test-and-Repair facilities. Results are expressed in terms of percent reduction in ASM 2525 emission rates. The sample of vehicles tested at Test-Only stations after failing the initial test show much greater emission reductions than the sample tested at Test-and-Repair stations after failing the initial test. This data is also shown in TABLE 3.

2.4 Observed Impact of the Smog Check Program on Percentages of Super Emitters

The primary goal of an I/M program is to identify and force the repair of high emitting vehicles. Of primary interest is how the program impacts the percentage of super emitting vehicles – vehicles that emit at rates an order of magnitude greater than their certification standards. Theoretically, few vehicles should be super emitters after they have been certified in the Smog Check program. Using data from BAR's roadside test program, dKC estimated the impact of the Smog Check program on the percentages of the fleet that are classified as super emitters. Trends by station type – Test-Only vs. Test-and-Repair – were investigated.

dKC limited the analysis to 1980 to 1991 passenger cars that were tested in BAR's roadside test program (5644 observations). dKC used projected FTP emission rates in g/mi. as the basis for determining if a vehicle was classified as a super emitter.These projections were made by applying ERG's FTP conversion factors to the two-mode ASM results in the roadside dataset. For this analysis, super emitters are defined as vehicles that exceed new vehicle certification standards by the following multiples:

- HC – 9 times (> 3.69 g/mi.)
- CO – 10 times (>70.0 g/mi.)
- NOx – 4 times (>2.8 g/mi.)

Trends were evaluated by each pollutant and by all pollutants, i.e., classified as a super emitter for any of the pollutants.

Table 4 presents a breakdown of the percentages of super emitters before and after Smog Check by station type and model year group. As shown, much greater reductions in the incidence of super emitters were observed for vehicles certified at Test-Only stations than Test-and-Repair stations. In addition, after Smog Check, there were much lower percentages of super emitting vehicles among the sample that was certified at Test-Only stations. For example, 10.8% of the 1980 to 1986 vehicles certified at Test-and-Repair stations were HC super emitters, while 5.0% of the 1980 to 1986 vehicles certified at Test-Only stations were HC super emitters.

TABLE 4
Percent of Super Emitters Before and After Smog Check Certification
By Station Type and Model Year Group

Model Year Group	Station Type	Pollutant	Super Emitters (%) Before Smog Check	Super Emitters (%) After Smog Check	Reduction in Super Emitters (%)
1980-86	Test-and-Repair	HC	13.07%	10.83%	17.19%
		CO	9.35%	6.98%	25.35%
		NO_x	13.07%	13.11%	-0.24%
		Any Pollutant	25.28%	23.08%	8.72%
	Test-Only	**HC**	**13.76%**	**5.03%**	**63.41%**
		CO	**9.63%**	**3.36%**	**65.15%**
		NO_x	**13.34%**	**10.40%**	**22.03%**
		Any Pollutant	**26.69%**	**15.10%**	**43.41%**
1987-91	Test-and-Repair	HC	1.93%	2.31%	-19.50%
		CO	1.21%	0.98%	19.11%
		NO_x	4.92%	3.47%	29.47%
		Any Pollutant	6.93%	5.87%	15.34%
	Test-Only	**HC**	**2.52%**	**1.27%**	**49.79%**
		CO	**2.52%**	**0.63%**	**74.89%**
		NO_x	**4.62%**	**0.63%**	**86.31%**
		Any Pollutant	**7.98%**	**1.90%**	**76.22%**

3.0 INVESTIGATION INTO DIFFERENCES BETWEEN TEST-ONLY AND TEST-AND-REPAIR INSPECTION PERFORMANCE

The following factors may help explain why Test-Only stations achieve better performance than Test-and-Repair stations:

- Test-Only stations fail more vehicles that have high emissions.
- Better repairs are performed if the vehicle's certification test is performed at a different station than the station that repaired the vehicle.
- Test-Only stations perform more accurate and complete reinspections, and may not incorrectly certify as many high emitting vehicles as Test-and-Repair facilities.

The accuracy of Test-Only vs. Test-and-Repair stations in failing high emitting vehicles can be addressed by analyzing data on the following:

- Vehicles that undergo Smog Checks after they exceed Smog Check standards in roadside tests.
- Vehicles that are tested in the roadside inspection program after they pass their initial Smog Checks.

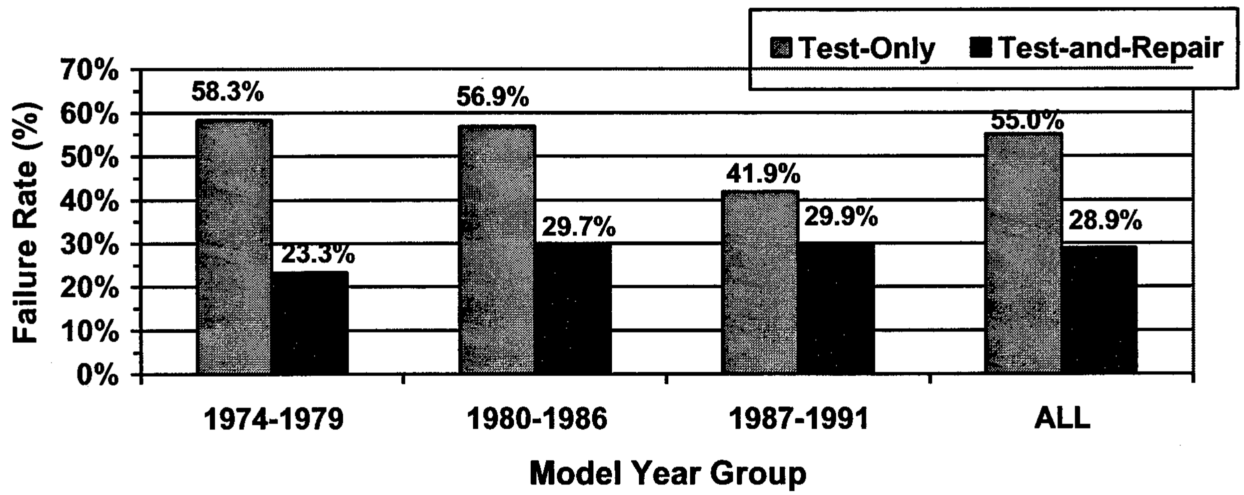
The performance of Test-Only vs. Test-and-Repair stations in certifying that failed vehicles comply with Smog Check standards can be assessed by analyzing data on vehicles that are tested in the roadside test program after they fail their initial Smog Checks and then pass.

3.1 Analysis of Smog Check Station Results on Vehicles That Exceed ASM Standards in Roadside Tests

Results of roadside tests that were performed before vehicles are given their Smog Check can help us assess the accuracy of the initial smog inspections. Of primary interest are the Smog Check results on vehicles that exceeded ASM standards during the roadside tests. Although some of these vehicles will be repaired prior to inspection, one would expect that most of the vehicles would still be in a high emissions state when they were inspected. Consequently, they should fail their initial Smog Check. The exception would be for NQ since Smog Check standards for station inspections are significantly less stringent than roadside standards.

Figure 5 compares the failure rate (tailpipe failure rate only) for the Smog Check that was performed after the roadside test on vehicles that exceeded Smog Check standards during the roadside test. These results differ from the results shown on Table 1 in that here we are comparing reported failure rates for vehicles that exceeded Smog Check standards on prior roadside tests, while Table 1 shows the differences in roadside failure rates before and after Smog Check Certification. As shown, the failure rate was about twice as high for the Test-Only stations versus the Test-and-Repair stations.

FIGURE 5
Comparison of Failure Rates
Failed Roadside Test before Smog Check



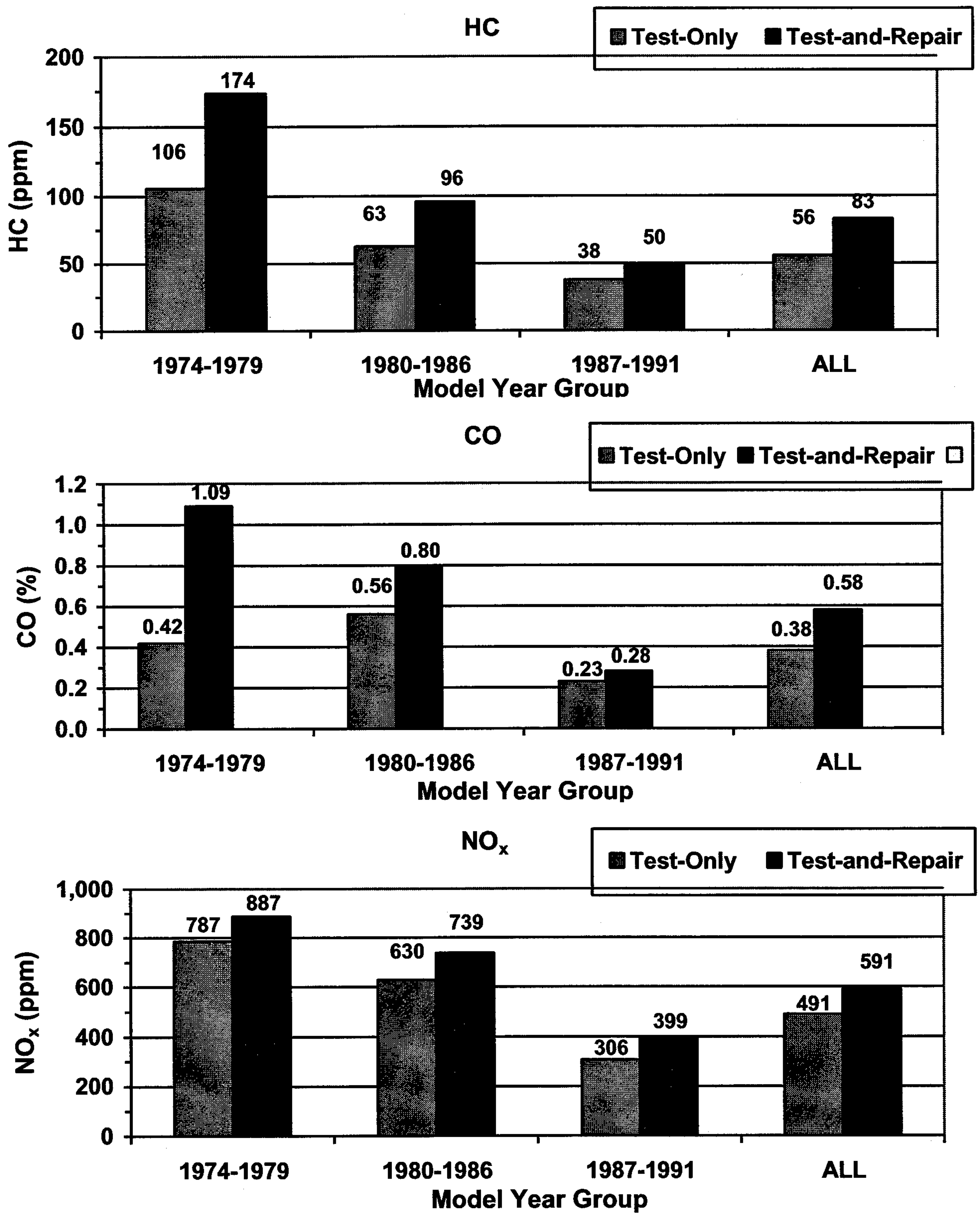
This figure shows the emissions failure rate that was reported by Smog Check stations on vehicles that exceeded Smog Check standards in roadside tests that were conducted prior to the Smog Check. The higher failure rate reported by Test-Only stations might indicated that they perform more reliable and accurate inspections than Test-and-Repair stations.

3.2 Analysis of Roadside Test Results on VehiclesAfter They Passed Their Initial Smog Check

The results of roadside tests that were conducted after vehicles were certified in the Smog Check program again reveals much about the performance of different types of stations. Vehicles may have been improperly certified if they have high emissions during subsequent roadside tests.

Ideally, a vehicle that passes its initial test should have low emission rates when inspected at a subsequent roadside test. Figure 6 summarizes roadside emission trends for vehicles that passed initial tests in different types of stations, broken down by model year group. Results are expressed in terms of ASM 2525 emissions. ASM 5015 emissions show the same trends.
As shown, vehicles certified at Test-Only stations had lower emissions in the roadside tests that followed than those certified at Test-and-Repair stations. This indicates that Test-and-Repair stations may be improperly certifying some of the vehicles, possibly through improper test procedures or clean piping.

FIGURE 6
Roadside ASM 2525 Emissions for Vehicles that Pass Their Initial Station Smog Check



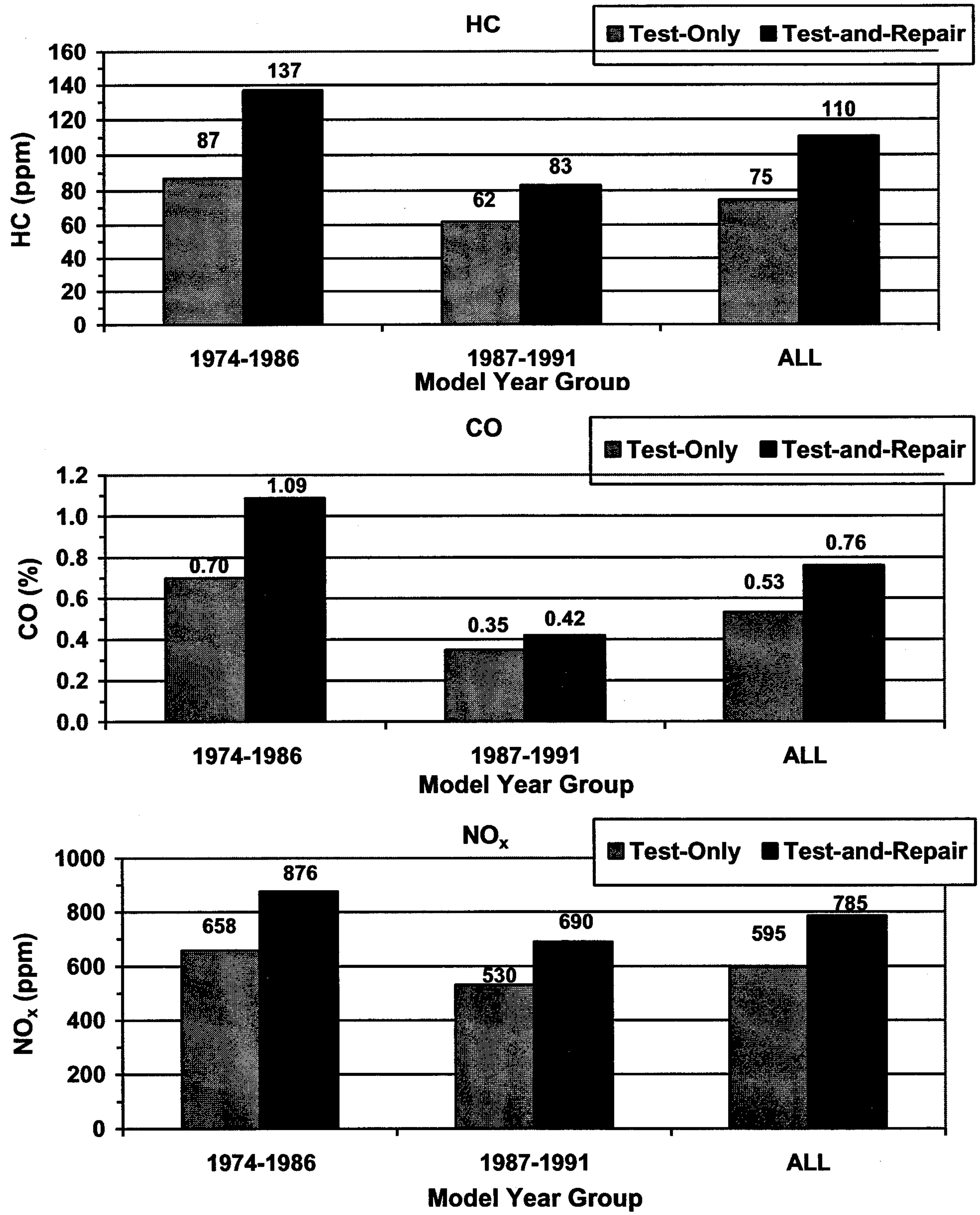
This figure shows average Roadside ASM 2525 emissions by pollutant for vehicles that pass their initial Smog Check. Lower emissions are observed for vehicles tested at Test-Only stations.

3.3 Analysis of Roadside Test Results on Vehicles that Passed Smog Check After Previously Failing

The matched dataset indicated if a vehicle that passed its Smog Check had previously failed a Smog Check in the prior six-month period. These are the vehicles thatare presumed to have been repaired. BAR identified these vehicles by analyzing data from the Vehicle Information Database (VID) to determine if previously there was a failing record. Vehicles that are improperly certified or that received inadequate repairs are likely to have higher emissions on subsequent roadside tests.

Figure 7 summarizes the emission trends for vehicles that pass their station Smog Check after failing an initial Smog Check at the station. Results are expressed in terms of ASM 2525 emissions. ASM 5015 emissions show the same trends. Vehicles that passed their retests (presumably after repairs) at Test-Only stations had significantly lower HC, CO, and NO emissions than those that passed their retest at Test-and-Repair stations. These results indicate that repairs may be more complete if a vehicle is retested at a Test-Only station. They also could indicate that Test-and-Repair stations might be more likely to falsely pass a vehicle, either through clean piping or improper test procedures.

FIGURE 7
Roadside ASM 2525 Emissions for Vehicles that Pass Their Station Smog Check After Failing Their Initial Station Smog Check



This figure shows average ASM 2525 emissions results by pollutant for vehicles that pass after failing their initial Smog Check. Lower emissions are observed for vehicles tested at Test-Only stations, implying that they received more complete repairs.

4.0 RANKING THE PERFORMANCE OF INDIVIDUAL STATIONS

In order for an I/M program to achieve maximum benefits, all stations must perform accurate and complete emission tests before and after repairs. Based on the analysis presented in sections 2 and 3, vehicles certified at Test-Only facilities show much greater exhaust emission reductions and lower after Smog Check emission levels than vehicles certified at Test-and-Repair facilities. dKC and ERG investigated the performance of the different types of Test-and-Repair stations with the goal of identifying characteristics of high performing stations – stations that appear to have similar performance to Test-Only stations. These characteristics could then be incorporated into performance standards for Test-and-Repair stations.

Possible performance standards were calculated using data stored in BAR's Vehicle Information Database (VID), a database containing all Smog Check results. The standards were evaluated using data collected from roadside tests performed between February 1997 and October 1999.

4.1 Emission Reductions by Station Type

Before we discuss possible performance standards, emission reductions for different types of stations will be reviewed. Within the Test-and-Repair category, there are three types of stations:

- Gross Polluter Certification (GPC)
- Gold Shield Registered (GSR)
- Regular Test-and-Repair (REG)

We evaluated the performance of the above stations using two basic parameters:

- Observed emission reductions based on roadside tests before and after Smog Check.
- Observed roadside emission levels after Smog Check.

We concentrated on hydrocarbon (HC) emissions during the ASM 2525 cycle. Emission standards for oxides of nitrogen (NO_x) were not in place for much of the roadside test period, so observed NO_x emissions are not as valid as observed HC emissions for program evaluation.

Table 5 compares HC emissions before and after Smog Check for vehicles certified by different station types. Results for Test-Only stations are shown for comparison purposes. Vehicles certified by GPC stations appear to have greater emission reductions and lower after Smog Check emission levels than vehicles certified by GSR or regular Test-and-Repair stations, but the sample sizes for the GPC group is small. Vehicles certified at Test-Only stations appear to have greater emission reductions than all the Test-and-Repair groups.

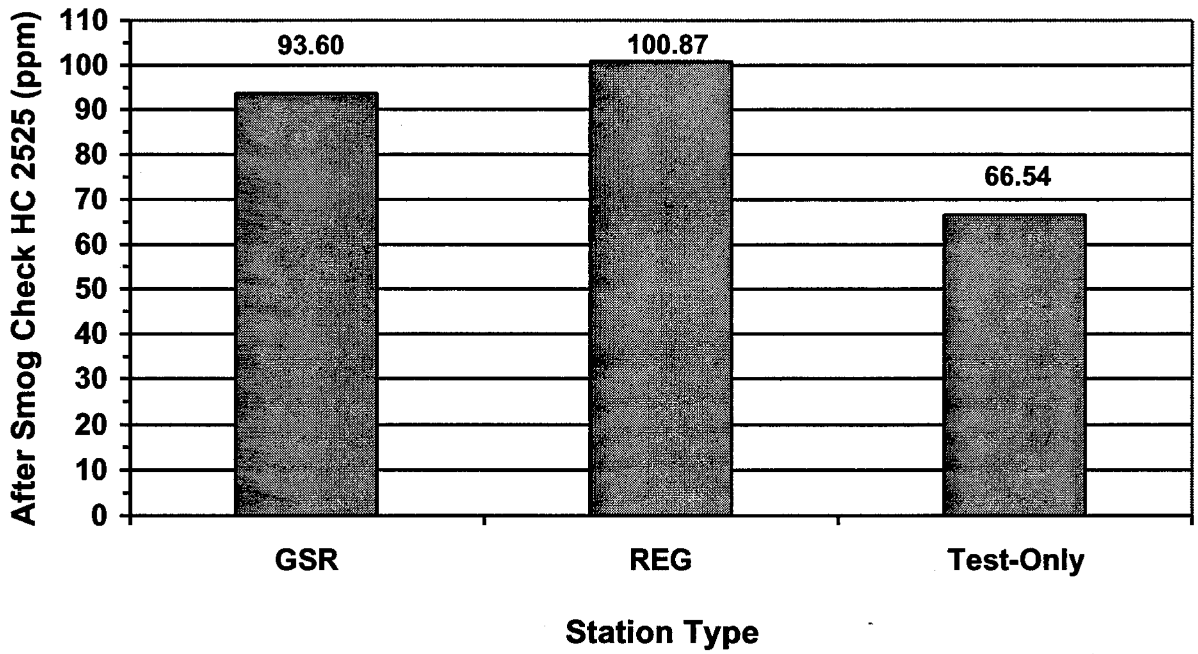
Figure 8 compares after repair HC emissions levels by station type for the 1980 to 1986 vehicles. Vehicles within the 1980 to 1986 group are not significantly impacted by BAR's policy of directing high emitters to Test-Only stations. These vehicles are as a group high emitting and thus it does not matter that a few are directed to Test-Only stations. For the purpose of evaluation, it can be assumed that all station types are inspecting 1980 to 1986 vehicles with similar emissions. After Smog Check HC emission levels for vehicles certified by GSR and regular Test-and-Repair stations were much greater than the levels for Test-Only certification. There were insufficient data to include GPC stations by model year group in the comparison.

TABLE 5
Roadside HC 2525 Emissions and Percent Reductions by Test-and-Repair Station Type and Model Year

Station Type	Model Year Group	Parameter	Before Smog Check	After Smog Check	Reduction (%)
GPC	ALL[2]	Average HC 2525	63.70	44.30	30.45%
		Count	189	148	
GSR	1974-1979	Average HC 2525	251.94	201.79	19.91%
		Count	88	67	
	1980-1986	Average HC 2525	98.19	93.60	4.67%
		Count	500	288	
	1987-1991	Average HC 2525	56.91	50.68	10.94%
		Count	596	524	
	ALL	Average HC 2525	88.84	76.26	14.15%
		Count	1184	879	
Regular (REG)	1974-1979	Average HC 2525	289.68	194.21	32.96%
		Count	241	112	
	1980-1986	Average HC 2525	121.01	100.87	16.65%
		Count	1062	631	
	1987-1991	Average HC 2525	56.07	53.74	4.16%
		Count	1099	994	
	ALL	Average HC 2525	108.22	79.92	26.15%
		Count	2402	1737	
Test-Only (TO)	1974-1979	Average HC 2525	211.08	106.04	49.76%
		Count	108	46	
	1980-1986	Average HC 2525	113.41	66.54	41.33%
		Count	870	371	
	1987-1991	Average HC 2525	51.89	40.28	22.36%
		Count	303	215	
	ALL	Average HC 2525	107.10	60.48	43.52%
		Count	1281	632	

[2] Insufficient data for a breakdown by model year.

FIGURE 8
Comparison of After Smog Check HC 2525 Emissions
1980 to 1986 Vehicles



This figure compares after Smog Check HC emissions during the ASM 2525 test for Test-Only stations with different types of Test-and-Repair stations. Vehicles certified at GSR and Regular Test-and-Repair stations have much higher after Smog Check levels to those certified at Test-Only stations.

4.2 Ranking Test-and-Repair Stations Based on Reported Failure Rates

dKC and ERG investigated ways to rank the different Test-and-Repair stations. Our goal was to determine if ranking parameters could be developed thatidentify Test-and-Repair stations with similar performance to Test-Only stations. This section presents station rankings based on observed vs. expected failure rates for each station in the Enhanced program area. ERG ranked the stations using the procedure presented below.

The ERG rankings are based on the actual failure rate at a station compared with the expected failure rate. Data from BAR's VID were used to calculate expected and reported failure rates. The expected failure rate at a station is based on the average failure probability of the set of vehicles that were tested at the station. The difference between the actual and expected failure rate is used to develop the final rankings. The standard error of the expected failure rate is also considered in determining these rankings. The difference between the actual and expected failure rates is divided by the standard error of the expected failure rate to determine how the station's actual failure rate compares to the expected failure rate. The following equation is used to calculate the number of standard deviations between the actual and expected failure probabilities.

$$N_\sigma = \frac{(F_p - FR)}{Std\ Err}$$

F_p = Average expected Fail Rate at Station
FR = Actual Fail Rate at Station
Std Err = Standard Error of the Expected Fail Rate at Station

N_σ is used to rank the station from the lowest value to the highest. Stations at the top of the list report failure rates that exceed the expected failure rates. Their N_σ values are negative. Stations at the bottom of the list report failure rates that are much lower than expected failure rates. Their N_σ values are positive.

The fleet was broken down into 4 categories from top to bottom ranks based on N_σ:

- 0 to 25% of all stations -- The highest ranked stations.
- 25 to 50% of all stations
- 50 to 75% of all stations
- 75 to 100% of all stations -- The lowest ranked stations.

Table 6 shows a breakdown in the percentages of Test-and-Repair and Test-Only stations by rank, along with the percent of vehicles inspected by these stations, based on 1999 VID data.

TABLE 6
Percent of Stations by Rank

N_σ Ranking	Test-Only		Test-and-Repair	
	Percent of Stations	Percent of Vehicles Inspected	Percent of Stations	Percent of Vehicles Inspected
0-25% (Best)	59.9%	12.8%	21.2%	19.3%
25-50%	21.5%	3.6%	25.4%	17.3%
50-75%	12.3%	2.5%	26.4%	18.1%
75-100% (Worst)	6.3%	1.4%	27.0%	25.0%
All	100.0%	20.2%	100.0%	79.8%

Table 7 compares HC emissions before and after Smog Check for vehicles certified by different ranks of Test-and-Repair stations. Stations with too few observations to generate statistically valid N_σ were put in the unranked category. As shown, after Smog Check HC emission levels for the top 25% of the Test-and-Repair stations are much lower than the bottom 25%, even though average emissions before Smog Check for the top 25% group are significantly higher than average emissions for the bottom 25% group. Collectively, stations falling in the Top 75% based on N_σ reduced HC emissions by 30%, while stations falling in the bottom 25% (the 75-100% group) showed no reductions in HC emissions.

TABLE 7
Emission Reductions by Failure Probability Ranking -- 0-25% is best
Test-and-Repair 1980 to 1991 Model Years

N_σ group	Parameter	HC 2525 Emissions		
		Before Smog Check	After Smog Check	Reduction (%)
Top 25% (0-25%) Best Stations	**Average of HC 2525**	**98.41**	**55.10**	**44.01%**
	Count	**813**	**543**	
25-75%	Average of HC 2525	71.35	59.48	16.64%
	Count	1140	906	
Bottom 25% (75-100%) Worst Stations	**Average of HC 2525**	**81.88**	**83.26**	**-1.68%**
	Count	**1092**	**825**	
Not ranked	Average of HC 2525	81.21	80.13	1.32%
	Count	392	301	
ALL	Average of HC 2525	82.22	68.59	16.58%
	Count	3437	2575	

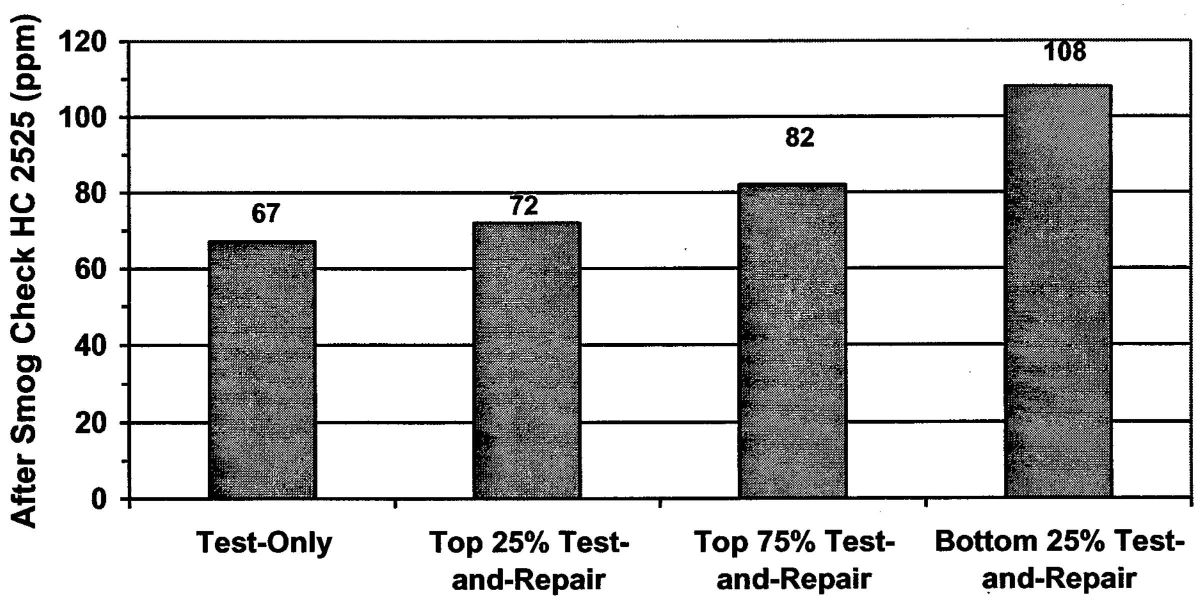
As shown on Table 7, HC emission reductions for vehiclescertified by the top 25% of the Test-and-Repair stations are significantly greater than the other groups. Conversely, Vehiclescertified by the bottom 25% of the Test-and-Repair stations show no HC emission reductions.

Figure 9 compares after Smog Check levels for ranked Test-and-Repair stations with Test-Only stations. As with the previous comparison of Test-Only vs. Test-and-Repair results shown on Figure 7, the dataset is limited to 1980 to 1986 model year vehicles to minimize concerns over sampling biases due to high emitters being directed to Test-Only facilities. After Smog Check HC emissions for the top 25% (0-25%) of Test-and-Repair stations averaged 72 ppm; after Smog Check HC emissions for the Test-Only stations averaged 67 ppm. Vehiclescertified at the bottom 25% of the Test-and-Repair stations had much higher emissions after Smog Check, averaging 108 ppm HC. After Smog Check HC emissions for the top 75% of Test-and-Repair stations averaged 82 ppm.

Table 8 presents a breakdown of the percentages of super HC emitters before and after Smog Check for Test-and-Repair stations broken down by their ERG failure rate rank. Super emitters are defined in Section 2.4. As shown, a much greater reduction in the incidence of super emitters was observed for vehicles certified at the top 25% of Test-and-Repair stations (0-25%) than at the bottom 25% (75-100%). In addition, after Smog Check there were much lower percentages of super HC emitting vehicles among the sample that was certified at the top 25% of Test-and-Repair stations. For example, 7.6% of the 1980 to 1991 vehicles certified at the bottom 25% of Test-and-Repair stations were HC super emitters, while 3.9% of the 1980 to 1991 vehicles certified at the top 25% of Test-and-Repair stations were HC super emitters. The percent of super emitters after Smog Check for the top 25% of Test-and-Repair stations were similar to the percent for Test-Only stations.

To further validate the station rankings based on N_σ, we ranked different types of Test-and-Repair stations (GPC, GSR, and REG) and compared the observed emission reductions. Table 9 shows observed HC emissions before and after Smog Check by station type and rank. For all station types, the bottom 25% showed the highest emissions and lowest emission reductions. This further confirms that Test-and-Repair stations falling into to the bottom 25% perform inferior inspections. The top 25% consistently showed the greatest emission reductions. Furthermore, these reductions generally were similar to those observed for the Test-Only group.

FIGURE 9
Comparison of After Smog Check HC 2525 Emissions for Ranked Test-Only Stations and Test-and-Repair Stations (1980 to 1986 Vehicles)



This figure compares after Smog Check HC emissions during the ASM 2525 test for the ranked Test-and-Repair stations with Test-Only stations. The highest ranked stations, the top 25%, had HC emissions close to the Test-Only group, implying they achieved similar benefits.

TABLE 8
Percent of Super Emitters Before and After Smog Check Certification
1980 to 1991 Vehicles by Failure Rate Rank

Station Type	Fprob Rank	Parameter	Super Emitters (%)		
			Before Smog Check	After Smog Check	Reduction (%)
Test-and-Repair	**0-25%**	**HC Super Emitter (%)**	**7.97%**	**3.95%**	**50.48%**
		Count	**552**	**380**	
	25-75%	HC Super Emitter (%)	5.26%	4.86%	7.62%
		Count	799	659	
	75-100%	HC Super Emitter (%)	9.39%	7.58%	19.21%
		Count	767	567	
Test-Only		**HC Super Emitter (%)**	**10.98%**	**3.73%**	**66.06%**
		Count	**965**	**456**	

TABLE 9
Emission Reductions by Failure Rate Ranking and Station Type: 0-25% is best -- TEST-AND-REPAIR - 1980 to 1991 Model Years

Station Type	N_σ group	Parameter	Before Smog Check	After Smog Check	Reduction (%)
GPC	0-25%	Average of HC2525	53.62	43.07	19.67%
		Count	64	47	
	25-75%	Average of HC2525	52.23	43.95	15.87%
		Count	71	56	
	75-100%	Average of HC2525	26.9	64.6	-140.15%
		Count	10	10	
	Not ranked	Average of HC2525	61.14	36.67	40.03%
		Count	33	24	
	ALL	Average of HC2525	52.96	43.88	17.15%
		Count	178	137	
GSR	0-25%	Average of HC2525	91.92	47.31	48.53%
		Count	218	162	
	25-75%	Average of HC2525	61.70	52.22	15.37%
		Count	395	292	
	75-100%	Average of HC2525	69.43	74.54	-7.35%
		Count	369	280	
	Not ranked	Average of HC2525	113.85	124.78	-9.60%
		Count	114	78	
	ALL	Average of HC2525	75.74	65.90	12.98%
		Count	1096	812	
REG	0-25%	Average of HC2525	106.47	60.56	43.12%
		Count	531	334	
	25-75%	Average of HC2525	79.02	64.83	17.95%
		Count	674	558	
	75-100%	Average of HC2525	89.09	88.17	1.03%
		Count	713	535	
	Not ranked	Average of HC2525	69.23	68.13	1.59%
		Count	243	198	
	ALL	Average of HC2525	87.98	72.04	18.12%
		Count	2161	1625	

Table 10 compares HC emissions before and after Smog Check for vehicles certified by different ranks of Test-Only stations. There are no significant differences in the after Smog emission levels for the top and bottom groups of Test-Only stations. This implies that most Test-Only stations have similar performance in assuring that vehicles comply with standards when they are certified to pass Smog Check requirements.

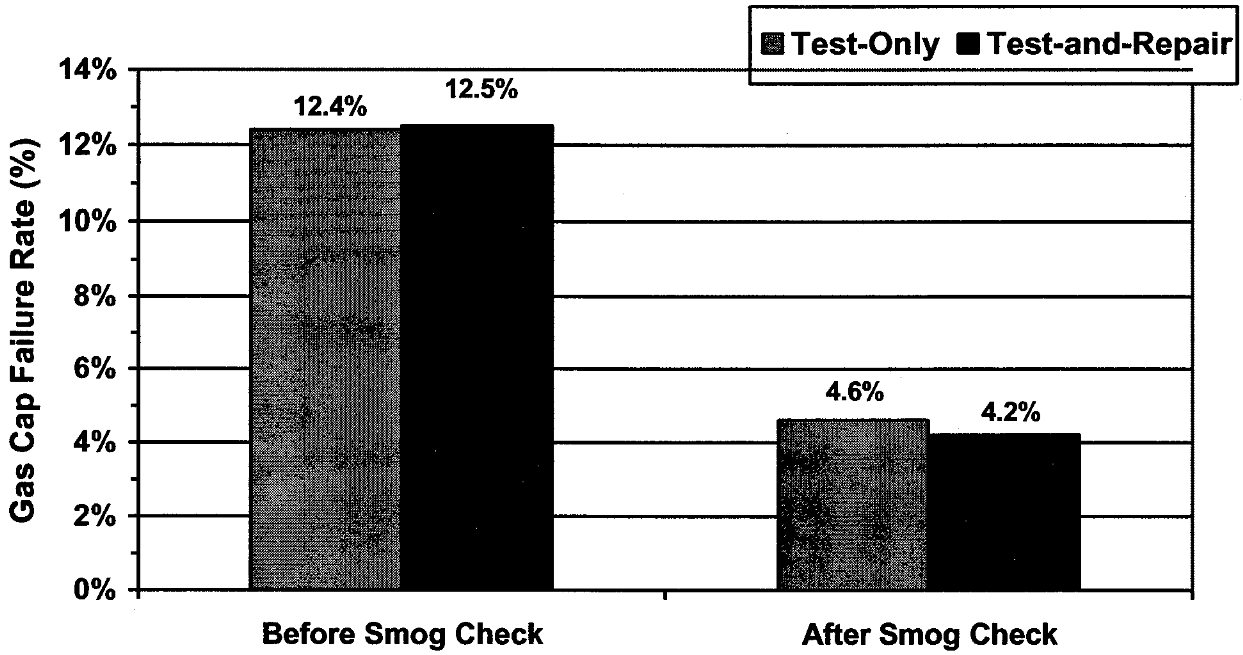
TABLE 10
Emission Reductions by Failure Rate Ranking:
TEST-ONLY 1980 to 1991 Model Years

N_σ group	Parameter	Before Smog Check	After Smog Check	Reduction (%)
0-25%	Average of HC 2525	118.85	65.41	44.97%
	Count	870	392	
25-50%	Average of HC 2525	83.50	53.28	36.19%
	Count	176	93	
50-75%	Average of HC 2525	65.01	50.96	21.61%
	Count	141	85	
75-100%	Average of HC 2525	98.75	49.50	49.87%
	Count	76	52	
Not Ranked	Average of HC 2525	134.67	72.60	46.09%
	Count	18	10	
ALL	Average of HC 2525	107.10	60.48	43.52%
	Count	1281	632	

5.0 IMPACT OF THE SMOG CHECK PROGRAM ON GAS CAP FAIL RATES

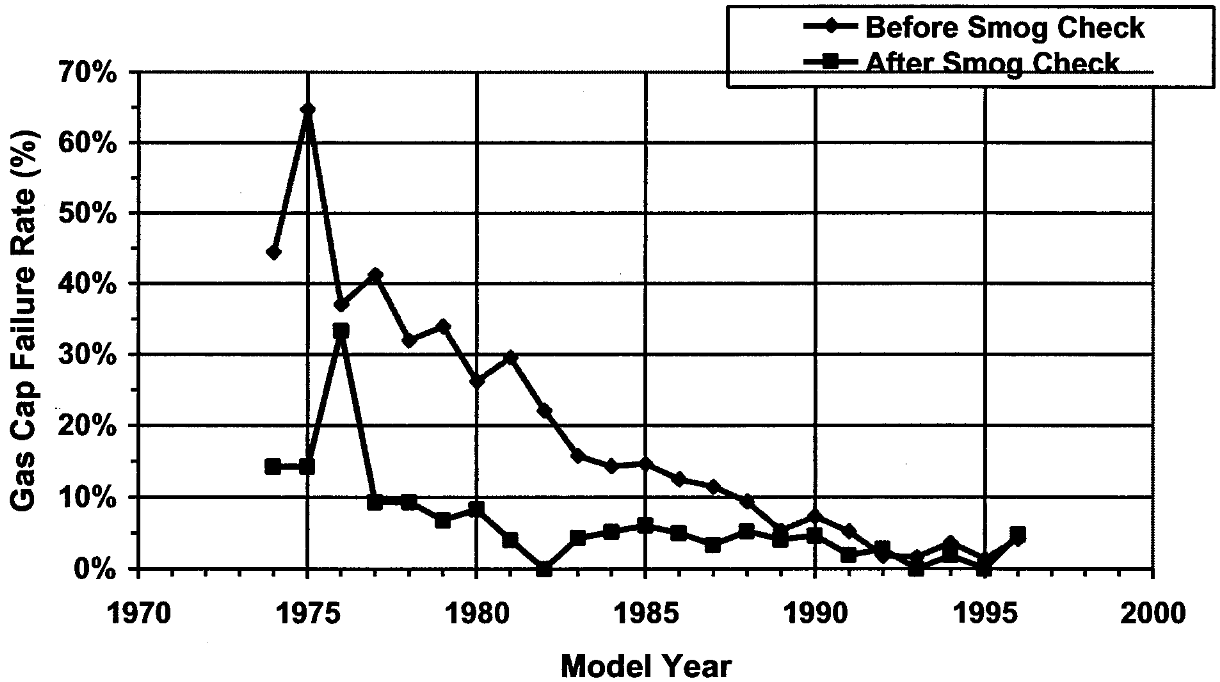
dKC investigated the impact of the Enhanced Smog Check Program on gas cap fail rates and found that the program significantly reduced the incidence of gas cap failures. The gascap fail rate before Smog Check was 12.4%. The after Smog Check fail rate was 4.29% or 65.5% lower. The reductions were the same for Test-Only and Test-and-Repair stations (Figure 10). Furthermore, as shown on the Figure 11, the impact was very consistent by model year.

FIGURE 10
Gas Cap Failure Rate (%)



This figure compares failure rates for the gas cap pressure test before and after Smog Check. After Smog Check failure rates are much lower than before Smog Check failure rates. There is no difference between Test-and-Repair and Test-Only stations in terms of the impact on gas cap failure rates.

FIGURE 11
Gas Cap Failure Rate (%)



This figure compares failure rates by vehicle model year for the gas cap pressure test before and after Smog Check. After Smog Check failure rates are much lower than before Smog Check failure rates for most of the model years.

6.0 COMPARISON OF FLEET EMISSION REDUCTIONS FOR A TEST-ONLY VS. TEST-AND-REPAIR INSPECTION NETWORK

Using data from roadside emissions tests, ERG estimated fleet emission reductions for two scenarios:

- 100% Test-Only Inspection Network
- 100% Test-and-Repair Inspection Network

ERG first converted results of the ASM test into projected emissions during the Federal Test Procedure (FTP). ERG then calculated projected FTP emission levels in grams/mile before and after Smog Check. After Smog Check results were divided into vehicles that were certified at Test-Only and Test-and-Repair stations. Total tons per day benefits for the two scenarios were calculated by multiplying the difference in grams/mile emissions before and after Smog Check by estimates of daily vehicle miles traveled (VMT).

6.1 Fleet Average Predicted FTP Emissions

ASM results in concentrations were converted into predicted FTP rates (g/mi) using the latest conversion equations developed by Radian/ERG. These conversion equations are described in the Radian/Eastern Research Group (ERG) report titled, "Equations for Estimating California Fleet FTP Emissions from ASM Concentrations," dated January 13, 2000.

Once the predicted FTP emission rates were determined, the fleet average FTP emission rates were calculated using the following methodology:

1. Calculate the average predicted FTP emission rate by model-year for each pollutant (HC, CO and NO_x);

2. Multiply the average predicted FTP emission rate for each model-year and pollutant by the respective travel fraction for that model-year; and

3. Sum the products for each model-year by pollutant to determine the overall fleet average predicted FTP emission rate for each time period.

6.2 Predicted FTP Emission Rates Before and After Smog Check Inspection

ERG then calculated Before and After Smog Check emission levels for vehicles undergoing BAR97 ASM tests in the enhanced Smog Check program. California's VID records were matched with the roadside sample. Vehicles which had completed the BAR-97 ASM test requirement were selected for this analysis. Vehicles which had either passed the BAR-97 ASM test or had 90 days lapse since producing a BAR-97 ASM test failure were assumed to have completed the I/M requirements. This dataset contained vehicle model-years 1974 through 1995. This subset is representative of the After BAR-97 I/M fleet. To complete the analysis for model-years that are not covered by the program, 1966 to 1973 model-year estimates and 1996 to 1999 model-year estimates from the roadside sample during the same time period have been added to the After I/M dataset.

Tables 11 through 13 show the results of this analysis. Table 11 shows the Before Smog Check emission levels; Table 12 shows After Smog Check emission levels for vehicles that were certified at Test-and-Repair stations; Table 13 shows After Smog Check emission levels for vehicles that were certified at Test-Only stations. The 1966 to 1973 model-year and 1996 to 1999 model-year estimates are shown in italics. The overall fleet estimates weighted by travel fraction are shown at the bottom of the table.

6.3 Estimated Reductions in Tons per Day

The weighted average exhaust emission rates in grams per mile were multiplied by estimated daily VMT to calculate tons per day exhaust emissions. We used the same VMT estimates that ARB used in its report *Evaluation of California's Enhanced Vehicle Inspection and Maintenance Program (Smog Check II), April 27, 2000.* For evaporative emissions reductions, we used ARB's estimate of 25 tons per day. Based on the gas cap test results discussed in Section 5, we used the same evaporative emission reductions for Test-Only and Test-and-Repair stations.

Emission reductions were calculated by subtracting the After Smog Check emission estimates for the two scenarios – Test-Only and Test-and-Repair – from Before Smog Check emission estimates. Table 14 summarizes the results of this analysis. ARB's current estimates for the program also are presented. As shown, total HC plus NO_x estimates for the Test-Only scenario are about double the estimated reductions for the Test-and-Repair scenario. Switching to a 100% Test-Only scenario, or equivalent in terms of Test-and-Repair performance standards, is estimated to increase emission reductions for the current program by 80 tons per day.

TABLE 14
Emission Reductions in Tons per Day – Test-Only vs. Test-and-Repair

Scenario	Emission Reductions – Tons per Day			
	HC Evaporative	HC Exhaust	NO_x	Total HC+NO_x
Current Program	**25**	**74**	**24**	**123**
100% Test-and-Repair	**25**	**53**	**19**	**97**
100% Test-Only	**25**	**125**	**53**	**203**

TABLE 11
Predicted FTP Emission Rates by Model-Year for Vehicles Tested on Roadside before a BAR97 ASM Smog Check Inspection

Model-year[a]	Number of vehicles	HC (g/mi)	CO (g/mi)	NO_x (g/mi)
1966	*24*	*8.62*	*97.6*	*1.86*
1967	*20*	*10.77*	*109.0*	*2.34*
1968	*29*	*7.81*	*77.1*	*2.20*
1969	*17*	*9.62*	*96.9*	*3.16*
1970	*30*	*6.83*	*78.2*	*2.65*
1971	*22*	*6.08*	*77.9*	*2.66*
1972	*32*	*9.25*	*77.1*	*2.59*
1973	*62*	*8.18*	*79.1*	*2.43*
1974	42	9.05	73.4	3.16
1975	28	5.08	73.6	2.61
1976	40	8.00	56.4	2.82
1977	89	6.74	55.9	2.65
1978	104	6.28	49.2	2.79
1979	122	4.59	47.6	2.57
1980	110	3.56	55.6	2.06
1981	121	3.93	53.5	2.07
1982	144	3.20	45.6	1.91
1983	208	2.98	37.5	2.27
1984	319	2.92	38.7	1.93
1985	460	2.38	27.8	1.80
1986	515	1.66	20.8	1.64
1987	456	1.48	19.1	1.52
1988	417	1.30	14.4	1.41
1989	518	0.90	10.5	1.13
1990	444	0.78	8.6	0.95
1991	448	0.62	7.3	0.84
1992	132	0.66	7.8	0.82
1993	139	0.42	5.2	0.57
1994	157	0.36	4.8	0.55
1995	237	0.33	4.3	0.49
1996	*232*	*0.22*	*3.0*	*0.34*
1997	*61*	*0.20*	*2.3*	*0.30*
1998	*64*	*0.17*	*2.0*	*0.24*
1999	*11*	*0.12*	*1.6*	*0.17*
Weighted Average[b] :	5,854	1.14	13.2	0.91

[a] The predicted FTP emissions are for the roadside sample tested after November 11, 1998.
[b] Weighted by May 1999 model-year travel fraction table.

TABLE 12

Predicted FTP Emission Rates by Model-Year for Vehicles Tested on Roadside After a *Test and Repair* BAR97 ASM Smog Check Inspection

Model-Year[a]	Number of vehicles	HC (g/mi)	CO (g/mi)	NO_x (g/mi)
1966	*24*	*8.62*	*97.6*	*1.86*
1967	*20*	*10.77*	*109.0*	*2.34*
1968	*29*	*7.81*	*77.1*	*2.20*
1969	*17*	*9.62*	*96.9*	*3.16*
1970	*30*	*6.83*	*78.2*	*2.65*
1971	*22*	*6.08*	*77.9*	*2.66*
1972	*32*	*9.25*	*77.1*	*2.59*
1973	*62*	*8.18*	*79.1*	*2.43*
1974	13	7.02	52.9	3.09
1975	14	5.13	49.3	2.89
1976	15	4.51	67.3	2.71
1977	38	6.26	58.5	2.51
1978	36	4.41	50.7	2.83
1979	51	4.69	49.7	2.24
1980	46	4.53	55.5	2.06
1981	41	2.57	37.1	2.07
1982	58	4.38	42.2	1.86
1983	84	2.07	27.2	2.00
1984	136	2.20	30.0	1.83
1985	220	2.01	26.8	1.82
1986	286	1.39	17.6	1.59
1987	297	1.53	17.8	1.51
1988	290	1.07	12.6	1.25
1989	324	0.94	10.0	1.13
1990	299	0.73	8.6	0.97
1991	300	0.55	6.3	0.76
1992	63	0.54	6.7	0.76
1993	59	0.38	4.8	0.51
1994	98	0.34	4.4	0.49
1995	47	0.28	3.4	0.43
1996	*232*	*0.22*	*3.0*	*0.34*
1997	*61*	*0.20*	*2.3*	*0.30*
1998	*64*	*0.17*	*2.0*	*0.24*
1999	*11*	*0.12*	*1.6*	*0.17*
Weighted Average[b] :	3,419	1.03	12.0	0.87

[a] 1966 through 1973 vehicles are not subject to the Smog Check Program and the first four model-years (1996 through 1999 vehicles) were not subject to biennial Smog Check inspection requirements. Therefore, the predicted FTP emissions from the roadside sample after November 11, 1998 were used for these model-years.

[b] Weighted by May 1999 model-year travel fraction table.

TABLE 13
Predicted FTP Emission Rates by Model-Year for Vehicles Tested on Roadside After a *Test Only* BAR97 ASM Smog Check Inspection

Model-Year[a]	Number of vehicles	HC (g/mi)	CO (g/mi)	NO_x (g/mi)
1966	*24*	*8.62*	*97.6*	*1.86*
1967	*20*	*10.77*	*109.0*	*2.34*
1968	*29*	*7.81*	*77.1*	*2.20*
1969	*17*	*9.62*	*96.9*	*3.16*
1970	*30*	*6.83*	*78.2*	*2.65*
1971	*22*	*6.08*	*77.9*	*2.66*
1972	*32*	*9.25*	*77.1*	*2.59*
1973	*62*	*8.18*	*79.1*	*2.43*
1974	1	4.25	49.3	4.29
1975	1	5.61	86.8	1.29
1976	3	4.48	95.5	1.59
1977	14	2.64	33.1	2.81
1978	12	2.32	30.3	1.88
1979	17	4.16	37.1	2.45
1980	14	2.73	43.7	1.29
1981	24	2.73	44.1	2.29
1982	40	2.25	28.3	1.85
1983	47	1.97	27.6	1.88
1984	80	1.61	19.5	1.86
1985	85	1.65	21.2	1.43
1986	80	1.28	15.0	1.57
1987	66	1.14	14.8	1.21
1988	53	0.99	11.2	0.98
1989	40	0.80	8.5	1.10
1990	22	0.59	6.7	0.87
1991	26	0.47	5.1	0.70
1992	6	0.72	7.4	0.87
1993	4	0.36	4.0	0.58
1994	6	0.41	5.0	0.33
1995	4	0.20	2.4	0.23
1996	*232*	*0.22*	*3.0*	*0.34*
1997	*61*	*0.20*	*2.3*	*0.30*
1998	*64*	*0.17*	*2.0*	*0.24*
1999	*11*	*0.12*	*1.6*	*0.17*
Weighted Average[b] :	1,249	0.88	10.5	0.80

[a] 1966 through 1973 vehicles are not subject to the Smog Check Program and the first four model-years (1996 through 1999 vehicles) were not subject to biennial Smog Check inspection requirements. Therefore, the predicted FTP emissions from the roadside sample after November 11, 1998 were used for these model-years.

[b] Weighted by May 1999 model-year travel fraction table.

APPENDIX A

DATA ANALYSIS METHODOLOGY

This appendix describes the matched dataset and how it was analyzed.

Description of Matched Dataset

The "matched dataset" was created by BAR and then transmitted to dKC and ERG for analysis. BAR matched 27,080 roadside emissions test records (collected from February 10, 1997 to October 29, 1999) with official Smog Check station inspections. Station inspection results are collected and stored in BAR's Vehicle Information Database (VID).

BAR found official Smog Check test records or "VID records" that matched license plates or vehicle identification numbers (VINs) for 22,643 of the 27,080 vehicles that receive roadside emission tests. For most vehicles there was only one VID record since the majority of vehicles pass the first time tested; other vehicles had multiple VID records. Some vehicles received both a pre-inspection test as well as an official test that displayed a passing result. Other vehicles failed initial tests and received one or more "retests" before finally passing.

Next, BAR identified the VID record closest to the roadside event based on the test dates regardless of the test result (pass or fail). For example, a particular vehicle failed an initial Smog Check test on September 21st and was retested on September 28th and 29th , before finally passing the station Smog Check test on September 30th. Based on its roadside test date of October 27, 1999, the station test on September 30th was considered the official Smog Check test closest to the roadside event.

BAR then sorted the data into the following two groups. Data within these two groups were further sorted by the type of station (test-only or test-and-repair) that performed the official Smog Check test. A final subgroup was formed based on the station Smog Check test result. The vehicle either passed or failed the station Smog Check closest to the roadside test.

- BEFORE SMOG CHECK: Roadside emission test results for vehicles that had a roadside test *before* an official BAR-97 ASM Smog Check inspection performed at a licensed Smog Check station.

- AFTER SMOG CHECK: Roadside emission test results for vehicles that had a roadside test *after* an official BAR-97 ASM Smog Check inspection performed at a licensed Smog Check station. The vehicle described above was included in this group since its roadside test on October 27, 1999, was performed *after* its station inspection on September 30th.

For the purpose of this evaluation, only data meeting the following criteria were analyzed:

1. Vehicles with model years 1974 to 1991. There were only a few 1992 and newer vehicles in the matched dataset, particularly those that failed their Smog Check inspection.

2. Vehicles with less than one year (365 days) between the roadside test date and the station Smog Check test date. Whenever the sample size was sufficient, the analysis was duplicated for the subset of vehicles with less than six months (180 days) between the roadside test date and the station Smog Check test date.

3. Vehicles receiving BAR-97 ASM tests at Smog Check stations. This report focuses on matched test results for vehicles that received BAR97 ASM tests.

As a result of these edits, the final matched data set included 5,056 BEFORE SMOG CHECK records and 3,497 AFTER SMOG CHECK records.

Table A-1 summarizes the sample sizes for the different groups and subgroups of the matched dataset used in this analysis.

TABLE A-1
Breakdown of Sample Sizes

Test Type	Station Type	Roadside Test Sequence	Smog Test Disposition	Model Year			
				1974-1979	1980-1986	1987-1991	All
BAR97 ASM	Test Only	Before Smog	All	108	869	302	1,279
			Failed	36	289	46	371
			Passed Initial	72	580	256	908
		After Smog	All*	52	398	222	672
			Failed/Passed	4	65	24	93
			Passed Initial	42	305	191	538
	Test and Repair	Before Smog	All	340	1,649	1,788	3,777
			Failed	54	296	168	518
			Passed Initial	286	1,353	1,620	3,259
		After Smog	All*	195	994	1,636	2,825
			Failed/Passed	22	99	85	206
			Passed Initial	169	867	1,525	2,561

*All includes vehicles that never had a passing result before their roadside tests.

OBDII FOCUS GROUP (2002030)
DISCUSSION GUIDE

Introduction

- ❑ Purpose of the study. (Improve services to vehicle owners)
- ❑ What participants have in common: 1996+ vehicles
- ❑ Ground rules:
  - ! Being recorded - audio and visual.
  - ! Speak one at a time - speak up.
  - ! No right or wrong answers - disagree without being disagreeable.
  - ! There are no consequences to any of your answers.
- ❑ Introduction of group members - Occupation, make and model of car or truck.

Your Vehicle

- ❑ Now let's talk more specifically about the vehicle you drive:
  - ! What do you like best about it?
  - ! Least?
  - ! All in all, are you glad you bought it?
  - ! Do you wish you had something different?
  - ! What kinds of problems have you had with it?

Malfunction Indicator Light

(Hand out picture)

- ❑ Do you know what this is? What does the light mean?
- ❑ Is the purpose of the light clear to you? Why not?

- ❑ Has your MIL ever illuminated? More than once?
- ❑ If so, what did you do about it? What did you learn?

State Emissions Testing Program

- ❑ What kind of experiences have you had with the emissions testing program required by the state?
- ❑ Has a car of yours ever failed the emissions test? If so, what did you do about it?
- ❑ Have you ever cheated on the test, such as detuning your car for the test?
- ❑ Does the program do anything for cleaning the air or has it become a big joke?

On-Board Diagnostic System

- ❑ Does your vehicle have an on-board diagnostic system?
- ❑ Have you ever heard of it?

(Hand Out Tri-Fold Brochure)

- ❑ Have Rob explain what it is.
- ❑ Have any of you had an emission test done since this January? If so, did you notice anything different?
- ❑ Beginning this year, 1996+ vehicles now receive an OBD test instead of a tailpipe test. How do you feel about an electronic inspection vs. the old tailpipe test? Why do you feel that way?

Communication With Vehicle-Owners

- ❑ What is the best way to communicate with people like you about the features and benefits of the On-Board Diagnostic system?
    - ! Radio/TV/Newspaper ads?
    - ! Insets or other direct mail?
    - ! Via your service advisor?

- ❑ Now I am going to pass out a mock-up of an ad. Take blue pencil and underline words, phrases or concepts that appeal to you, ring true, or motivate you. Use red pencil to underline anything that seems to be blatant bull. Then we will talk about it.

Incentives

- ❑ What kind of incentive would you need to pay more attention to the Malfunction Indicator Light when it goes on?

  - ! State provide free diagnostics?
  - ! 2-year exemption from emissions test when fixed?
  - ! Other?

Reaction to Remote Inspection Stations

- ❑ State is apparently considering remote emissions inspection stations, such as Jiffy Lubes, car dealerships, service stations, etc. What is your reaction to that? Good idea? Bad idea? Why?

Conclusion