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## **Report to the General Assembly Response to Public Act 92-0682**

“Effectiveness of On-Board Diagnostic I/M Testing”

September 2003





REPORT TO THE GENERAL ASSEMBLY  
RESPONSE TO PUBLIC ACT 92-0682

*“EFFECTIVENESS OF ON-BOARD DIAGNOSTIC I/M TESTING”*

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## **EXECUTIVE SUMMARY**

### Background

Illinois has had a vehicle inspection and maintenance (I/M) program since 1986 to help identify vehicles that are in need of repairs because they exceed air pollution limits. I/M is limited to vehicles registered in metropolitan Chicago and metropolitan East St. Louis, and it is one of Illinois' most important tools for improving air quality and meeting federal air quality standards. For example, I/M reduces emissions of ozone-forming hydrocarbons by 26 tons per day in northeastern Illinois.

Legislation signed into law last year (Public Act 92-0682) allows, and new federal regulations require, the Illinois EPA to replace traditional I/M tailpipe exhaust tests with a simpler and quicker test of the on-board diagnostic (OBD) system. All 1996 and newer cars and light trucks have powerful computers that use OBD technology to manage and monitor their operations. Because OBD testing is available only on model year 1996 and newer vehicles, Illinois EPA will continue to provide traditional tailpipe testing for the significant, but declining, portion of the affected fleet that is pre-1996.

The OBD system ensures that the engine runs at peak efficiency, and it will turn on a dashboard warning light to alert the motorist of any problems with engine and/or emissions control components as soon as they occur. Early detection of problems makes warranty coverage programs more effective. Moreover, OBD systems can detect problems before they become more expensive to repair.

### History of OBD Testing

Illinois EPA started OBD testing in January 2000 on an "advisory-only" basis, which means the results were not used to determine compliance, but they were made available to motorists. This gave Illinois EPA and our contractor, Envirotest, an opportunity to refine the OBD test. The next phase, which began July 2002 and continues through December 2003, uses OBD testing along with gas cap pressure tests to determine compliance. However, vehicles that fail the OBD test are given a second chance to pass with a tailpipe test. Beginning in January 2004, compliance for most 1996 and newer vehicles will consist solely of gas cap pressure tests and OBD tests.

## OBD Results: Faster and More Effective

OBD testing has proven to be faster and less likely to produce vehicle damage. In addition, vehicle owners have reported repair costs for OBD-failed vehicles that are comparable to or less than repair costs for vehicles that fail traditional tailpipe tests.

### **OBD Vehicle Inspection and Maintenance Testing in Illinois Phase-in Results through March 2002**

- OBD Emissions Test Duration: 50% faster than tailpipe testing
- Average Wait Time: 10% less since OBD testing began
- Vehicle Damage Claims: 42% less since OBD testing began
- Repair Costs: Comparable to or less than the most rigorous tailpipe test \*

\* In Illinois, repairs have averaged \$238 for vehicles that only failed the OBD test compared to \$404 for those that only failed the "IM 240" tailpipe test. Other states have experienced comparable repair costs for OBD test failures.

In 2002, forty percent of the vehicles completing an emissions test in Illinois were 1996 or newer and, therefore, OBD-equipped. With fleet turnover, OBD testing will gradually replace tailpipe testing, and this should further reduce customer wait times and vehicle damage claims.

## OBD Failure Rates

In Illinois, the fail rate for all vehicles undergoing the combined tailpipe and gas cap tests in 2002 was twelve percent. By comparison, the fail rate for OBD and gas cap testing on 1996 and newer models has been between seven and eight percent during the phase-in period. However, OBD fail rates should be considerably lower once OBD testing is fully implemented – roughly around three percent based on results from other states. Indeed, Illinois EPA believes many motorists will respond to the OBD warning system and have their vehicles repaired before undergoing the test, thereby lowering the initial failure rate. As noted above, vehicle owners have reported repair costs for OBD-failed vehicles that are comparable to or less than repair costs for vehicles that fail traditional tailpipe tests.

OBD test failures can be grouped into three categories:

- Engine and/or emissions control malfunctions (88.2 percent)
- OBD systems that don't work properly (10.5 percent)
- Missing or damaged connectors that are needed to link the OBD system with computers at testing facilities (1.3 percent)

Results also show that over twenty percent of OBD-equipped vehicles returning for retests were found to be "not ready." This happens when vehicles return to a test facility immediately after repairs are performed and the OBD systems are not ready to be tested.

Many vehicles require a period of normal driving to ensure that the OBD system has performed all required checks and is ready for testing again. This issue has been encountered in all states that have implemented OBD testing. Illinois EPA has increased outreach efforts to the public and repair technicians in order to address this issue.



## 1. INTRODUCTION

On July 16, 2002, Public Act 92-0682 was adopted, modifying Section 13B-25 of the Illinois Vehicle Code to phase-in the On-Board Diagnostics (OBD) system testing as part of Illinois' mandatory vehicle emissions inspection and maintenance (I/M) programs.

This report summarizes the effectiveness of OBD testing in Illinois, based upon review of data and information collected during the phase-in period beginning in July 2002 through March 2003.

OBD testing is required for all 1996 and newer light duty vehicles by the 1990 Amendments to the Clean Air Act and U.S.EPA regulations. U.S.EPA regulations<sup>1</sup> adopted in April 2001, required the use of OBD in I/M programs by January 2002. These regulations allow states to use OBD tests in place of existing exhaust emissions tests on vehicles equipped with second-generation OBD II technology. The regulations also provided flexibility to allow states to delay and/or phase-in OBD testing. States could delay startup for up to 12 months based on just cause, and take one test cycle to phase-in OBD testing by using OBD test results to "clean-screen" vehicles passing the OBD test, and to allow "second-chance" exhaust testing for vehicles failing the OBD test.

Public Act 92-0682 included provisions to incorporate elimination of exhaust testing for vehicles passing the OBD test (OBD clean screening), allow for, upon vehicle owner request, second-chance exhaust testing for vehicles failing the OBD test (Owner's Choice), and delay final implementation of full OBD testing until January 2004. A copy of Public Act 92-0682 is included as Attachment 1 to this report.

## 2. BACKGROUND – PURPOSE OF OBD TESTING

Beginning with the 1996 model year, all light-duty vehicles sold in the U. S. (including all passenger cars, trucks, vans, SUVs) are required by U.S. EPA to be equipped with standardized OBD systems. Basically, the OBD II system consists of a powertrain control computer and a number of sensors designed to monitor the operation of the engine, transmission, and emissions control components. This system is specifically designed to alert the driver of the occurrence of malfunctions causing or contributing to exhaust or evaporative emissions exceeding federal vehicle emissions standards. This is accomplished by illumination of the dashboard Malfunction Indicator Lamp (MIL)<sup>2</sup> during vehicle operation. It is important to note that the MIL is reserved for **emissions-related problems only** and is not illuminated for any other vehicle malfunctions.

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<sup>1</sup> 40 CFR Parts 51 and 85, Amendments to Vehicle Inspection Maintenance Program Requirements Incorporating the Onboard Diagnostic Check; Final Rule, 66 FR 18156 (April 5, 2001).

<sup>2</sup> The MIL when illuminated, will display either the phrase "Check Engine," "Service Engine Soon," or the ISO engine symbol.

If the MIL comes on and stays on, the OBD II system has detected a problem. Depending upon the problem, the driver may or may not notice any change in vehicle operation. With the MIL on, however, the vehicle is likely to have a condition that wastes fuel, shortens engine life, or causes an increase in vehicle emissions. If the MIL is blinking, a severe engine problem is occurring and should be checked as soon as possible since this indicates the occurrence of conditions likely to cause damage to the catalytic converter(s) on the vehicle.

When a malfunction is detected, diagnostic information is stored in the vehicle's computer memory for subsequent retrieval and use in diagnosing and repairing the vehicle. This includes diagnostic trouble codes (DTCs) documenting the nature of the problem as well as "freeze-frame" data that indicates engine operating parameters (e.g., vehicle speed, engine RPM, engine coolant temperature, air/fuel mixture, etc.) at the time the malfunction occurred. In the hands of a trained technician, this information is invaluable in diagnosing and correcting the problem.

OBD II systems are designed to provide both an immediate indication of the existence of one or more major malfunctions as well as to provide early warning of minor problems that, if left unattended, will become major problems requiring expensive repairs. The advantage of OBD II systems over traditional vehicle inspection programs is that these systems continuously monitor vehicle performance as opposed to annually or biennially when the vehicle is required to undergo the emissions test.

The 1990 Amendments to the Clean Air Act and U.S.EPA regulations require that all vehicle emissions inspection and maintenance programs include OBD system checks on all 1996 and newer vehicles equipped with standardized OBD II technology. The purpose of the OBD test is to identify and require repairs of vehicles with emissions-related malfunctions and to help ensure that vehicle owners become aware of the importance of the dashboard Malfunction Indicator Lamp (MIL). In eliminating the need to perform existing enhanced exhaust testing, the OBD test also provides opportunities to significantly reduce the cost of I/M programs. OBD testing is simple, quick and safe. It relies upon the use of a computer scan tool to download data stored in the memory of the vehicle's on-board computer.

### 3. THE OBD TEST

The OBD test consists of three basic steps:

1. A MIL bulb check is performed to verify that the bulb works. Like other dashboard warning lights, the MIL is designed to illuminate momentarily when ignition key is turned to the key-on position.
2. A scan tool<sup>3</sup> is connected to the vehicle's on-board computer to determine OBD II system "readiness" status,<sup>4</sup> MIL status (commanded on or off), and to download and diagnostic trouble codes (DTCs) that are stored in memory.
3. The test lane computer evaluates the data retrieved and makes a pass/fail determination using criteria shown in Table 1.

**TABLE 1  
OBD I/M PASS/FAIL CRITERIA**

|                         |  |
|-------------------------|--|
| <b>Vehicle Passes</b>   | <ol style="list-style-type: none"><li>1. Passes the bulb check;</li><li>2. The MIL is not commanded to be illuminated (MIL should be off); and</li><li>3. All required readiness flags are set to "ready".</li></ol>   |
| <b>Vehicle Fails</b>    | <ol style="list-style-type: none"><li>1. Fails the bulb check and/or;</li><li>2. MIL is illuminated (or commanded on) and DTC's (diagnostic trouble codes) are present, and/or</li><li>3. OBD II connector is missing, damaged, or inoperable (i.e., scan tool cannot communicate with the vehicle's on-board computer).</li></ol> |
| <b>Vehicle Rejected</b> | <ol style="list-style-type: none"><li>1. More than 2 unset readiness flags for 1996 – 2000 model years.</li><li>2. More than 1 unset readiness flag for 2001+ model years.</li></ol>   |

### 4. HISTORY OF OBD TESTING IN ILLINOIS

OBD testing in Illinois began in January 2000 when 1996 model year vehicles were eligible for testing for the first time. This initial OBD testing was conducted on an "advisory-only" basis. That is, results were not used to determine compliance, but were made available to motorists and their mechanics for use in diagnosing and repairing other emissions-related failures. Advisory testing also provided Illinois EPA and its test contractor (Envirotest Illinois, Inc.) with considerable experience in conducting OBD tests in anticipation of federal regulations requiring OBD testing as part of I/M testing.

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<sup>3</sup> A scan tool is automotive test equipment specifically designed to communicate with, and retrieve data from, the vehicle's on-board diagnostic computer.

<sup>4</sup> Readiness monitors are indicators used to determine if the vehicle's computer has evaluated the operational status of an emissions component. If all of the monitors are set to "ready", the OBD II system has checked the integrity of the emissions system. If a monitor is "not ready" at the time of the OBD test, the functionality of the emissions component is unknown. Readiness monitors are cleared (or "unset") every time a repair technician erases the DTCs (Diagnostic Trouble Codes) or the battery is disconnected (or runs down). In some cases, to set monitors to ready, the vehicle must be driven for several miles following driving patterns recommended by the manufacturer.

Throughout calendar years 2000 and 2001, Illinois EPA and Envirotest refined procedures and improved OBD test system hardware and software to increase test efficiency and quality.

## 5. ILLINOIS PHASE-IN OF OBD TESTING

Public Act 92-0682 authorized the Illinois EPA to phase-in the implementation of OBD testing. It eliminated the advisory nature of OBD testing and established a January 2004 deadline for full implementation of OBD testing. Beginning in July 2002, vehicles passing OBD and gas cap tests were considered to be in compliance with Illinois emission standards. Vehicles passing the OBD test were no longer required to take the IM240 or steady-state idle exhaust emissions test.<sup>5</sup> Owners of vehicles failing the OBD test were given the option (Owner's Choice) to receive a "second-chance" test consisting of the exhaust test (IM240 or idle as applicable to the vehicle) or decline the exhaust test and have the vehicle repaired. Vehicles passing the "second-chance" exhaust test were determined to be in compliance with Illinois emissions standards. Vehicles failing the exhaust test were required to have repairs performed and return for a retest.

Owner's Choice is designed primarily to allow owners concerned about potential vehicle damage caused during exhaust testing (primarily dynamometer-based IM240 testing) to opt-out of exhaust testing.

## 6. IMPLEMENTATION OF OWNER'S CHOICE

Upon passage of Public Act 92-0682, the Illinois EPA and Envirotest initiated design and engineering of test system changes required to implement Owner's Choice. In order to implement the changes as soon as possible, and because of the significant amount of test system software changes required, the Illinois EPA implemented the changes in phases:

- **Phase 1 - "Clean-Screen":** Exhaust testing was eliminated for vehicles passing the OBD test beginning July 22, 2002 (less than one week after the effective date of the legislation). During this phase, vehicles passing the OBD test (in addition to the required gas cap leak test) were issued a compliance certificate. Vehicles failing the OBD test continued to receive the exhaust test, which was used to determine compliance.
- **Phase 2 - "Owner's Choice":** Second-chance exhaust testing for vehicles failing the OBD test became optional on October 21, 2002. Immediately after an OBD test failure, the results and options were discussed with the motorist. If the motorist chose to take the second-chance exhaust test, the inspectors proceeded to conduct the exhaust emissions test. If the motorist declined, the vehicle failed the

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<sup>5</sup> In accordance with federal regulations, for program evaluation purposes, one-tenth of one percent (0.1%) of vehicles receiving the OBD test continue to receive IM240 tests.

I/M test based upon the OBD test result. Currently, 95% of motorists elect to take the second-chance exhaust test.

- **Phase 3 - OBD Pass/Fail:** Phase-in of OBD testing is scheduled to end December 31, 2003. Beginning January 2, 2004, compliance for 1996 and newer OBD II-equipped vehicles will be based upon results of the OBD test and the gas cap leak test. Second-chance exhaust testing will no longer be available. All vehicles failing the OBD test will be required to repair the vehicle to meet OBD standards, or receive a waiver consistent with existing regulations.

## **7. OBD PHASE-IN RESULTS**

In 2002, approximately 40% of vehicles scheduled for testing in Illinois were equipped with OBD II technology, making them eligible for OBD testing. Of the approximately 1.7 million vehicles inspected in 2002, approximately 680,000 received OBD tests. The numbers and percentages of OBD II equipped vehicles and tests will increase each year with fleet turnover.

Between July 2002 (after implementation of OBD clean-screen) and March 2003, approximately 467,000 vehicles passed the OBD test, resulting in 467,000 fewer exhaust inspections. This has had a positive impact on Illinois test program operations and motorist convenience, resulting in significant reductions in the average time required to perform each test, the average time motorists are required to wait in line, and the number of test-related complaints and damage claims submitted to the Illinois EPA and its test contractor.

### **7.1 EFFECT ON TEST DURATION AND WAIT TIME**

The new OBD test takes much less time to perform than traditional exhaust testing. On average, OBD tests can be performed in five minutes or less, a significant improvement over traditional IM240 exhaust testing that has averaged over nine minutes per test. The shorter duration test translates into higher test lane throughput and lower average waiting times.

Figure 1 compares average test durations by test type for 1996 and newer vehicles. The figure compares average test duration for IM240 and idle testing measured prior to OBD Phase-in implementation, with OBD tests conducted after implementation of clean-screen and second-chance testing. As shown, OBD-only tests take approximately one-half the time to perform as compared to IM240 tests. With approximately one-third of vehicles tested receiving the OBD-only test, the average test duration for all tests has decreased from 9.1 minutes per test to 7.4 minutes per test, or a reduction of 19%.

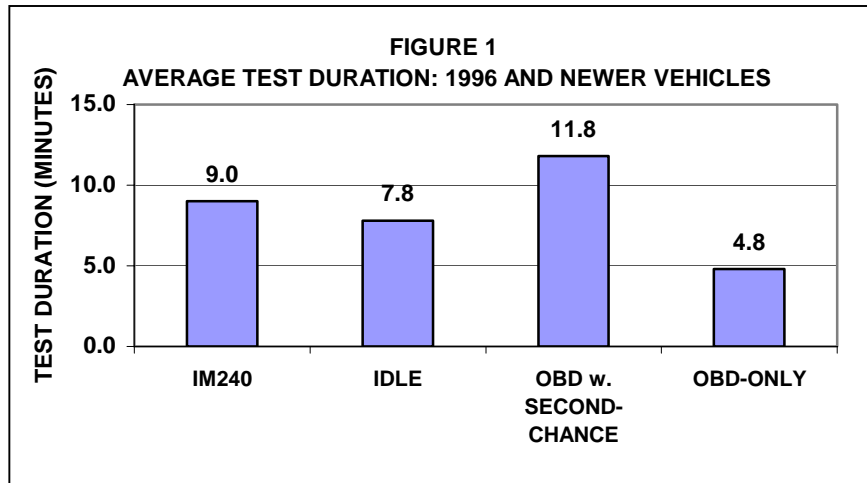
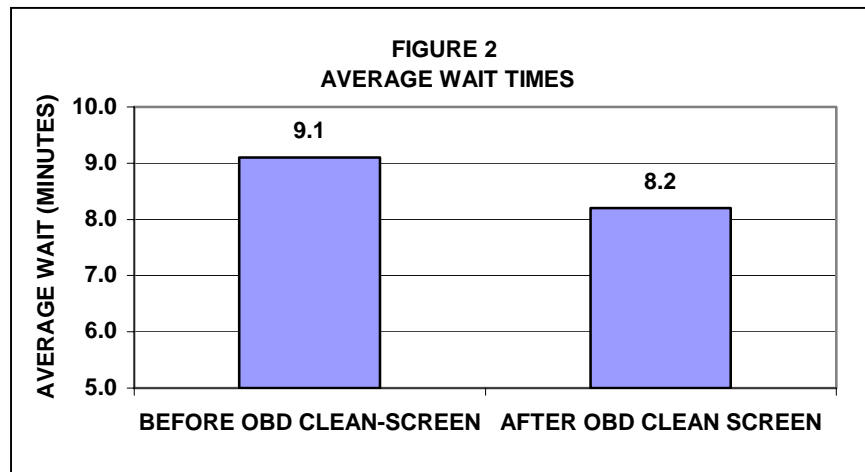


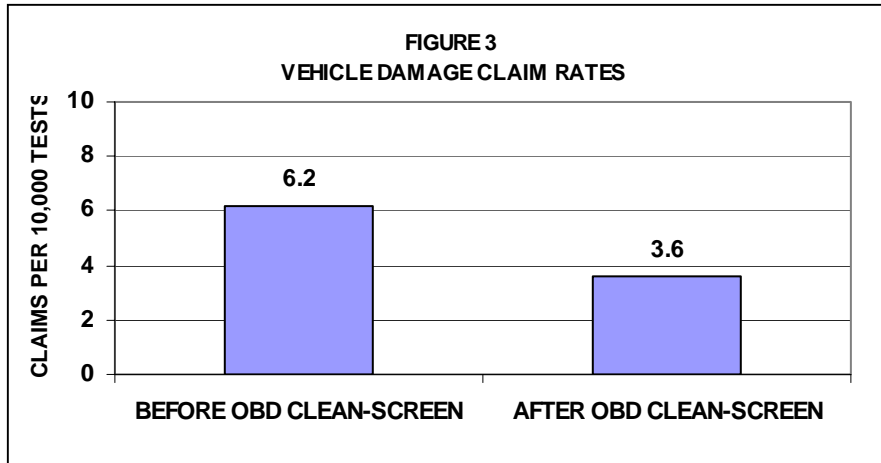
Figure 2 compares average motorist wait times for the same time periods. As shown, the increase in efficiency has resulted in a 10% reduction in wait times. The decrease in wait time has occurred even with a 3.4% increase in test volume in during the October 2002 - March 2003 evaluation period as compared to the same months the previous year.



## 7.2 EFFECT ON VEHICLE DAMAGE CLAIMS

Since implementation of the IM240-based Enhanced I/M program in 1999, motorist complaints regarding vehicle damage resulting from the emissions test have become an issue. Most claims filed by motorists are related to damage, real or perceived, from vehicle operation on the chassis dynamometer used to perform the IM240 transient test. Replacing the IM240 test with the OBD test should result in a significant decrease in motorist complaints and vehicle damage claims. As expected, OBD phase-in has resulted in a reduction in claims proportional to the reduction in IM240 tests performed.

Figure 3 shows the damage claim rate observed during the October 2002 – March 2003 period, as compared to the same period the previous year. As the OBD II equipped fraction the fleet increases over time, Illinois EPA expects a further reduction in the rate of claims.



### 7.3 MOTORIST USE OF OWNER'S CHOICE

Between October 21, 2002, and March 31, 2003, 27,225 vehicles failed the initial OBD test and 4,919 were rejected from OBD testing. In each case, facility management personnel explained OBD test results to motorists and offered the option of taking the second-chance exhaust test. Of the 32,144 offers, 30,787 or 96% of motorists chose to take the second-chance exhaust test. 1,121 or 3.5% specifically declined the offer, and 274 or 0.7% did not make a decision<sup>6</sup>.

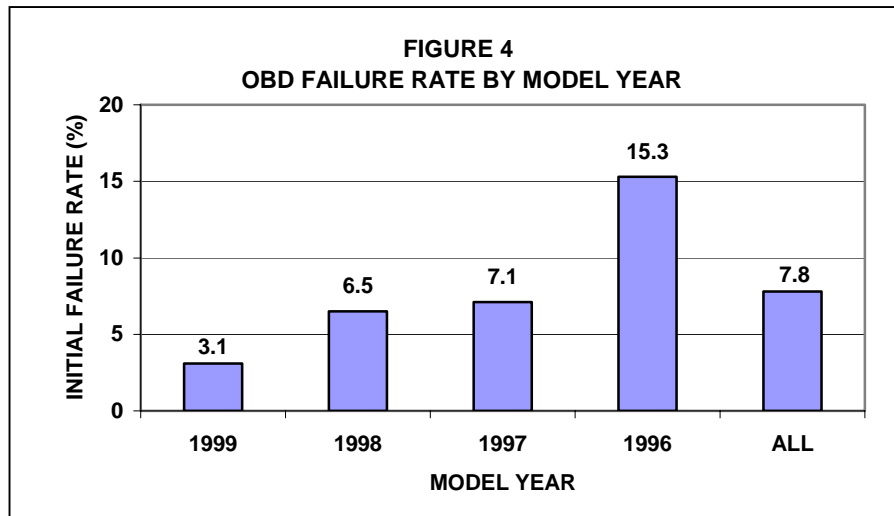
## 8. OBD FAILURE EVALUATION

Illinois EPA has evaluated OBD test data collected since October 21, 2002, to determine the distribution of OBD failures by reason and to identify the emissions control systems and components most frequently identified by stored diagnostic trouble codes.

<sup>6</sup> In cases where the motorist could not decide, the vehicles were rejected and the motorist was told to see the customer service representative in the office. This was done to maintain test lane throughput for the benefit of other motorists waiting to have their vehicles tested.

## 8.1 INITIAL FAILURE RATES

Figure 4 shows current initial test OBD failure rates by model year for the October 2002 through March 2003 period. During this period, an overall initial OBD failure rate of 7.6% was observed. As shown, the failure rate is relatively low for newer vehicles (3.1% for 1999 model year vehicles) and increases with vehicle age.



## 8.2 RESULTS OF SECOND-CHANCE TESTING

Approximately 96% of motorists chose to take the second-chance exhaust test after failing the OBD test. Of these 30,787 vehicles taking the exhaust test, 27,735 (90%) passed. At first look, this statistic would indicate that the OBD test is failing “clean cars.” This is not the case, for several reasons:

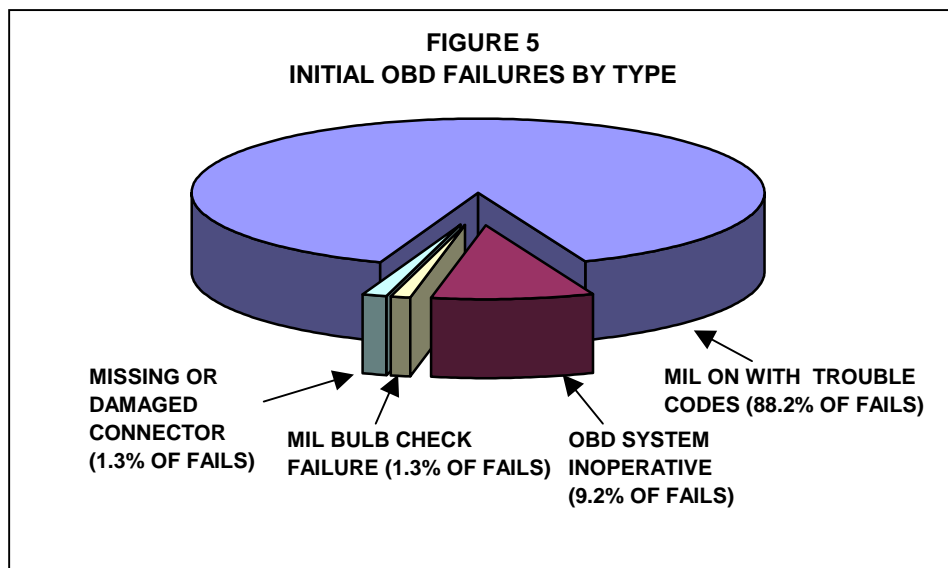
- The OBD test is more stringent than traditional exhaust emissions tests. Vehicle manufacturers are required by U.S. EPA to build OBD systems that will trigger MIL illumination whenever an engine or emissions-system malfunction can cause emissions to increase to levels 150% above federal certification standards. Limitations of exhaust test technology used in I/M programs (even the dynamometer-based IM240 test used in Illinois) require setting I/M exhaust standards at levels equivalent to 300-500% above federal certification standards.
- OBD is capable of monitoring systems during vehicle operating conditions not “seen” by existing I/M testing. The majority of vehicle emissions occur during “cold start” operation, that is, when the vehicle is warming up and emissions control systems are not functioning at peak efficiency. Traditional I/M tests are required to be performed with the vehicle and control equipment at normal operating temperature. As a result, malfunctions in equipment designed to limit

cold-start emissions (e.g. intake air pre-heat systems and heated oxygen sensors) are detected by the OBD system, but are missed by the exhaust test.

- OBD is capable of monitoring emissions control systems that current exhaust tests are not designed to check. OBD systems are designed to monitor the operation of the entire evaporative control system on a vehicle, while the existing I/M test checks only the integrity of the gas cap for leaks. The OBD system can detect leaks in the cap as well as fuel tank and vapor return lines, as well as ensure that canister purge controls are functioning properly.
- OBD detects problems that are masked by the robust nature of today's emissions control components. A part may fail without leading to an immediate increase in emissions at the tailpipe. Other components (like the catalyst) temporarily compensate for the part that is broken. However, this will often result in premature wear and tear on other emissions-related components that will eventually fail to perform as necessary. As such, OBD provides an "early warning" that repairs are needed before the vehicle would otherwise fail the exhaust test.

### 8.3 OBD FAILURE DISTRIBUTION BY TYPE

Figure 5 displays the distribution of observed failures by type. Most failures (88.2%) result in cases where the MIL is illuminated and diagnostic trouble codes are present. These results indicate that the vehicle is being operated with malfunctions in one or more engine or emissions-system components that should be diagnosed and repaired. To date, 9.2% of failing vehicles (0.7% of vehicles tested) were identified with inoperative OBD systems; 1.3% of failing vehicles (0.1% of vehicles tested) failed the bulb check used to verify that the MIL was working properly; and, 1.3% of failing vehicles (0.1% of vehicles tested) were found to have missing or damaged OBD connectors, preventing the test contractor from retrieving OBD data.



## 8.4 DIAGNOSTIC TROUBLE CODE EVALUATION

Results of the OBD test provide trained repair technicians with detailed information regarding the emissions-related malfunction(s). Retrieved DTCs are very specific and provide an indication of what component or components have malfunctioned or are operating out of specification. Table 2 summarizes, by major category, the percentages of failing vehicles reporting problems.

**TABLE 2  
OBD FAILURES BY MAJOR EMISSIONS COMPONENT CATEGORY**

| Component/Category               | Percentage of Failing Vehicles | Description   |
|----------------------------------|--------------------------------|---|
| Fuel and Air Metering            | 35.9                           | Modern computer-controlled vehicles require precise control of fuel and air mixtures to optimize vehicle performance, economy and emissions. Malfunctions in these systems can produce poor performance, poor fuel economy and increased emissions, and/or lead to premature degradation of major emissions control components (i.e., catalytic converters and oxygen sensors). |
| Ignition/Timing                  | 19.8                           | Ignition system malfunctions produce poor performance, high emissions and also lead to premature failure of major components.   |
| Exhaust Gas Recirculation System | 13.8                           | EGR systems recirculate a portion of exhaust gas into the engine to reduce peak combustion temperatures and emissions of oxides of nitrogen (NOx). Malfunctions of this system can cause increased NOx, reduce performance, and can lead to engine damage resulting from overheating.   |
| Catalytic Converter Efficiency   | 12.2                           | OBD II systems monitor the operating efficiency of the catalytic converter.   |
| Evaporative System               | 9.6                            | The system that collects and recycles gasoline vapors from the gas tank and fuel delivery system is not working properly, producing excessive hydrocarbon emissions to the atmosphere.  |

Table 3 lists the top 20 diagnostic trouble codes observed in Illinois along with the generic description of each.

**TABLE 3  
TOP 20 DIAGNOSTIC TROUBLE CODES REPORTED  
FOR VEHICLES FAILING THE OBD TEST**

| <b>DTC</b> | <b>Number/Percent</b> | <b>Description</b>   |
|------------|-----------------------|--|
| P0401      | 2137 (9.1%)           | Exhaust Gas Recirculation (EGR) Flow Insufficient          |
| P0420      | 2104 (8.9%)           | Catalyst System Efficiency Below Threshold (Bank 1)        |
| P0171      | 2006 (8.5%)           | System Too Lean (Bank 1)                                   |
| P0133      | 1751 (7.4%)           | Oxygen (O2) Sensor Circuit Slow Response (Bank 1 Sensor 1) |
| P0174      | 1500 (6.4%)           | System Too Lean (Bank 2)                                   |
| P0300      | 1348 (5.7%)           | Random/Multiple Cylinder Misfire Detected                  |
| P0141      | 1133 (4.8%)           | O2 Sensor Heater Circuit (Bank 1 Sensor 2)                 |
| P0430      | 1028 (4.4%)           | Catalyst System Efficiency Below Threshold (Bank 2)        |
| P0440      | 743 (3.2%)            | EVAP Control System  |
| P0301      | 716 (3.0%)            | Cylinder 1 Misfire Detected                                |
| P0153      | 708 (3.0%)            | O2 Sensor Circuit Slow Response (Bank 2 Sensor 1)          |
| P1443      | 706 (3.0%)            | Evaporative Emission Control System Control Valve          |
| P0304      | 658 (2.8%)            | Cylinder 4 Misfire Detected                                |
| P0134      | 610 (2.6%)            | O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 1)   |
| P0135      | 606 (2.6%)            | O2 Sensor Heater Circuit (Bank 1 Sensor 1)                 |
| P0303      | 583 (2.5%)            | Cylinder 3 Misfire Detected                                |
| P0302      | 580 (2.5%)            | Cylinder 2 Misfire Detected                                |
| P0403      | 561 (2.4%)            | EGR Control Circuit  |
| P1870      | 542 (2.3%)            | Transmission Component Slipping (Locking Torque Converter) |
| P0441      | 534 (2.3%)            | Evaporative Control System Vent Control Circuit            |

## 9. REPAIR EFFECTIVENESS

Illinois EPA has evaluated retest and repair data collected to date on vehicles failing the OBD test between October 21, 2002, and March 31, 2003. Of 5,149 OBD II vehicles failing the initial I/M test, 2,236 (43%) have returned for retesting as of April 30, 2003. Of the repaired vehicles, 2,003 (89.6%) successfully passed on retest. Of those vehicles that passed on retest, slightly more than one-half (53%) of these vehicles passed the OBD test, while the remainder failed or were rejected during the OBD retest but passed the second-chance exhaust retest.

Review of repair data submitted by motorists during the retest indicates an average cost of repair for a vehicle passing on retest after an OBD-only initial failure (vehicle failed the OBD test and the owner declined the second-chance exhaust test) was \$238. This is significantly less than the \$403 average total cost of repair for vehicles failing the IM240 exhaust test in calendar year 2002. The average repair cost for vehicles that failed both the OBD test and the second-chance exhaust test was higher at \$424.

## **10. OTHER OBSERVATION/ISSUES**

### **10.1 OBD SYSTEM READINESS ISSUES**

The relatively high number of second-chance exhaust retests can be attributed to a significant percentage of vehicles returning for the retest too soon after repair. The check of OBD readiness status made during the retest indicated that the vehicle's OBD system had not completed verification of emissions control system performance. Over 500 vehicles (23%) returned with more than two readiness monitors unset, requiring the Illinois EPA to reject the vehicle from OBD testing. This high retest reject rate is contrasted to the reject rate for initial OBD tests of 1.4%.

Readiness monitors are cleared ("unset") every time a technician erases the vehicle's OBD system of stored DTC's. Clearing codes is a normal part of the repair process. Once repairs are complete and codes cleared, the technician can confirm the effectiveness of the repair by driving the vehicle until all readiness monitors are set to "ready" or "complete". If all monitors have been run, and no fault codes return, the repair is successful. Once readiness monitors are set, the vehicle is prepared for an I/M retest.

Diagnostic trouble codes and readiness monitors are also cleared by disconnecting the battery or letting the battery run down. Disconnecting the battery is a common practice used by motorists to attempt to circumvent OBD testing. Evaluating readiness status (and rejecting vehicles with too many unset monitors) is used to counteract these attempts.

The high readiness reject rate on retest is an issue that Illinois EPA is addressing in preparation for final implementation of OBD-only testing in January 2004. States that have already fully implemented OBD testing have addressed the issue through focused public information and education as well as through repair industry outreach. Once the public and industry became more aware of the issue, reject rates dropped significantly.

### **10.2 OBD VS. TAILPIPE RESULTS**

Of 30,787 vehicles receiving both the OBD and exhaust emissions tests, 27,235 or 90% passed the exhaust test. On the surface, these results seem to imply that the OBD test is failing "clean" vehicles (i.e., those passing the IM240 or idle exhaust test). This conclusion requires an understanding of the differences between the two tests and what they are trying to accomplish. While tailpipe tests sample exhaust to see if it below or above prescribed limits, the OBD system is looking for broken or malfunctioning components that directly contribute to excessive emissions, or will lead to excessive emissions in the future (due to the effect of the malfunction on emission system deterioration and long-term performance). For example, the OBD system may identify a component failure that does not produce an immediate increase in emissions at the tailpipe, but will eventually cause other, more expensive components to fail. Major components (like the catalytic converter) can compensate for the part that is broken to a certain degree. These components can only do double duty for so long before they begin

to malfunction. As such, OBD systems provide an “early warning” that repairs are needed before the vehicle fails the tailpipe test.

OBD systems also identify problems that tailpipe tests are incapable of detecting. Malfunctions in emissions controls designed to reduce emissions at start-up (i.e., “cold-start” emissions) are not detectable by tailpipe tests taken when the vehicle is at normal operating temperature. OBD systems also monitor for leaks in fuel and evaporative control systems, problems that the tailpipe test cannot identify. While the Illinois program checks for missing/leaking gas caps, other problems with the evaporative system have gone undetected (until OBD II required manufacturers to monitor the entire evaporative control system). OBD also monitors for malfunctions in exhaust gas recirculation (EGR) systems designed to limit emissions of oxides of nitrogen (NOx). Since the Illinois program currently limits exhaust testing to hydrocarbons and carbon monoxide, vehicles with EGR malfunctions are not identified with existing tailpipe tests.

### **10.3 COMMUNICATION ISSUES**

During the OBD phase-in, Illinois EPA has identified several vehicle-specific issues making OBD testing difficult for those vehicles. While federal OBD regulations required vehicle manufacturers to utilize standardized communication protocols in the OBD II system, a small number of vehicles have been produced and sold that do not follow the standardized specifications. As a result, the test equipment Illinois is using cannot communicate with a small number of vehicle makes/models. This issue is not unique to Illinois, but affects all other states running I/M programs. Despite this, current OBD data capture rates are in the 98-99% range.

A related issue involves the relatively high rate of OBD failures attributed to inoperative OBD systems (INOP) on vehicles. Illinois EPA is currently evaluating these results and has determined that a significant percentage of OBD INOP failures are due to additional vehicle/scan tool communication problems limited to specific vehicle makes/models.

Illinois EPA is working with the U.S. EPA, Envirotest, Vetronix Corporation (OBD test equipment supplier) and vehicle manufacturers to address these issues.

### **10.4 CONNECTOR ACCESSIBILITY ISSUES**

Illinois and other states have experienced difficulty in accessing OBD connectors on a small percentage of vehicle models. Federal regulations required manufacturers to locate connectors in readily accessible locations. Unfortunately, similar to the issue of non-standard communication protocols, some manufacturers positioned OBD connectors in hard to access locations, making OBD testing difficult. On certain models the OBD connectors are located behind dashboard or console panels, ashtrays, etc. Currently, Envirotest has found the connectors to be inaccessible on 0.3% of vehicles presented for OBD testing. In each case, the vehicle received the tailpipe test applicable to the vehicle

(IM240 in most cases). The Illinois EPA is working with Envirotest to improve procedures used to identify and access connectors on these vehicles.

## **11. SUMMARY**

P.A. 92-0682 authorized the phase-in of OBD testing on 1996 and newer light-duty vehicles. The phase-in incorporated the elimination of tailpipe testing for vehicles passing the OBD test, and allowed for optional second-chance tailpipe testing for vehicles that failed the OBD test.

The phase-in was implemented beginning in July 2002. Between July 22, 2002 and March 31, 2003, over 460,000 vehicles passed the OBD test and no longer received the tailpipe test. The impact on program operations and motorist convenience has been significant, with reductions in the average test duration, average wait time, as well as the number of vehicle damage claims filed associated with emissions testing.

During the phase-in period, an OBD failure rate of 7.8% was observed. Approximately 96% of vehicle owners chose to take the second-chance exhaust test, 90% of which passed. Retest data on vehicles failing the OBD test indicates a high rate of successful repairs (of vehicles failing between October, 2002 and March, 2003, approximately 90% of vehicles have returned and passed the test). Average repair costs for OBD repairs are comparable to those for vehicles failing the IM240 exhaust test.

Test data collected during the phase-in period has identified several issues that are currently being addressed by the Illinois EPA and the test contractor. This includes vehicle-specific problems in communication between OBD scanners and OBD computers on a small number of vehicles, and the relatively high percentage of vehicles returning for retests with OBD systems in a “not ready to test” condition.

## Attachment 1

State of Illinois  
Public Acts  
92<sup>nd</sup> General Assembly  
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### Public Act 92-0682

HB5255 Enrolled

LRB9211482DHmg

AN ACT regarding vehicles.

Be it enacted by the People of the State of Illinois, represented in the General Assembly:

Section 5. The Illinois Vehicle Code is amended by changing Sections 13A-115 and 13B-25 as follows:

(625 ILCS 5/13A-115) (from Ch. 95 1/2, par. 13A-115)

Sec. 13A-115. Effectiveness. This Chapter 13A is repealed on January 1, 2003 ~~shall cease to be effective when the continuation of the program has been implemented under Chapter 13B.~~

(Source: P.A. 86-1433; 88-533.)

(625 ILCS 5/13B-25)

Sec. 13B-25. Performance of inspections.

(a) The inspection of vehicles required under this Chapter shall be performed only: (i) by inspectors who have been certified by the Agency after successfully completing a course of training and successfully passing a written test; (ii) at official inspection stations or official on-road inspection sites established under this Chapter; and (iii) with equipment that has been approved by the Agency for these inspections.

(b) Except as provided in subsections (c) and (d), the inspection shall consist of (i) a loaded mode exhaust gas analysis; (ii) an evaporative system integrity test; (iii) an on-board computer diagnostic system check; and (iv) a verification that all required emission-related recall repairs have been made under Title 40, Section 51.370 of the Code of Federal Regulations; ~~and~~ and may also include an evaporative system purge test. The owner of the vehicle or the owner's agent shall be entitled to an emission inspection certificate issued by an inspector only if all required tests are passed at the time of the inspection.

(c) A steady-state idle exhaust gas analysis may be substituted for the loaded mode exhaust gas analysis and the evaporative purge system test in the following cases:

(1) On any vehicle of model year 1980 or older.

(2) On any heavy duty vehicle with a manufacturer gross vehicle weight rating in excess of 8,500 pounds.

(3) On any vehicle for which loaded mode testing is not possible due to vehicle design or configuration.

(d) The procedures contained in subsections (d)(1) and (d)(2) of this Section shall be followed on model year 1996 and newer vehicles equipped with OBD on-board computer diagnostic equipment, as required.

(1) Beginning on July 1, 2002, and continuing through December 31, 2003, such vehicles shall be given a complete on-board diagnostic test consistent with the requirements of paragraphs (d)(1)(A) through (d)(1)(D) of this Section.

(A) If the vehicle meets the standards set for the complete on-board computer diagnostic test, neither the loaded mode exhaust gas analysis nor the idle exhaust gas analysis shall be performed; however, all other elements of the test contained in subsection (b) of this Section shall be performed.

(B) If, however, the vehicle fails to meet the standard for the complete on-board computer diagnostic test, it shall be given the loaded mode exhaust gas analysis or the idle exhaust gas analysis, as required, and all other elements of the test contained in subsection (b) of this Section, unless the owner of the vehicle chooses to avoid the loaded mode exhaust gas analysis or idle exhaust gas analysis and proceed directly under paragraph (d)(1)(C) of this Section. For those vehicles that fail to meet the standard for the complete on-board computer diagnostic test, the owner of the vehicle must be informed that he or she has the option to have the vehicle tested using the less stringent loaded mode exhaust gas analysis or the idle exhaust gas analysis, as appropriate, for one test cycle.

(C) If the vehicle fails to meet the standard for the complete on-board computer diagnostic test and the standard for the loaded mode exhaust gas analysis or the idle exhaust gas analysis, as required, or the owner of the vehicle has chosen to avoid the loaded mode exhaust gas analysis or idle exhaust gas analysis and proceed directly under this paragraph, the vehicle must be repaired to pass either the complete on-board computer diagnostic test or the loaded mode exhaust gas analysis or idle exhaust gas analysis, as required, and all other elements of the test contained in subsection (b) of this Section.

(D) The on-board computer diagnostic test shall not be a required element of the inspection mandated by this Section for such vehicles for which on-board computer diagnostic testing is not possible due to the vehicle's originally certified design or its design as modified in accordance with federal law and regulations, or for vehicles with known on-board diagnostic communications or software problems, as determined by the Agency. In such cases, all other elements of the inspection required under this Section shall be performed on such

vehicles, including the exhaust gas analysis as specified in subsection (b) of this Section.

By April 15, 2003, the Agency shall submit to the General Assembly a report detailing the effectiveness of the use of the on-board computer diagnostic test. The report shall include the number of failures, the reason for each failure, the number of vehicle damage complaints, and the average wait time at the test stations.

(2) Beginning on January 1, 2004, such vehicles shall be given a complete on-board diagnostic test consistent with the requirements of paragraphs (d)(2)(A) and (d)(2)(B) of this Section.

(A) The loaded mode exhaust gas analysis specified in subsection (b) of this Section shall not be performed on such vehicles for which the on-board computer diagnostic test specified in subsection (h) of this Section can be performed. All other elements of the inspection required for such vehicles shall be performed in accordance with the provisions of this Section.

(B) The on-board computer diagnostic test shall not be a required element of the inspection mandated by this Section for such vehicles for which on-board computer diagnostic testing is not possible due to the vehicle's originally certified design or its design as modified in accordance with federal law and regulations, or for vehicles with known on-board diagnostic communications or software problems, as determined by the Agency. In such cases, all other elements of the inspection required under this Section shall be performed on such vehicles, including the exhaust gas analysis as specified in subsection (b) of this Section.

~~A steady state idle gas analysis may also be substituted for the new procedures specified in subsection (b) in inspections conducted in calendar year 1995 on any vehicle of model year 1990 or older.~~

(e) The exhaust gas analysis shall consist of a test of an exhaust gas sample to determine whether the quantities of exhaust gas pollutants emitted by the vehicle meet the standards set for vehicles of that type under Section 13B-20. A vehicle shall be deemed to have passed this portion of the inspection if the evaluation of the exhaust gas sample indicates that the quantities of exhaust gas pollutants emitted by the vehicle do not exceed the standards set for vehicles of that type under Section 13B-20 or an inspector certifies that the vehicle qualifies for a waiver of the exhaust gas pollutant standards under Section 13B-30.

(f) The evaporative system integrity test shall consist of a procedure to determine if leaks exist in all or a portion of the vehicle fuel evaporation emission control system. A vehicle shall be deemed to have passed this test if it meets the criteria that the Board may adopt for an evaporative system integrity test.

(g) The evaporative system purge test shall consist of a procedure to verify the purging of vapors stored in the

evaporative canister. A vehicle shall be deemed to have passed this test if it meets the criteria that the Board may adopt for an evaporative system purge test.

(h) The on-board computer diagnostic test shall consist of accessing the vehicle's on-board computer system, if so equipped, and reading any stored diagnostic codes that may be present. The vehicle shall be deemed to have passed this test if the codes observed did not exceed standards set for vehicles of that type under Section 13B-20.

(Source: P.A. 90-475, eff. 8-17-97.)

Section 99. Effective date. This Act takes effect upon becoming law.

Passed in the General Assembly May 15, 2002.

Approved July 16, 2002.

Effective July 16, 2002.

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