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Assessing the Durability of Vehicle Emissions Systems: A Survey of Emission Component-Related Defect Reports in North America

by Kevin L. Fast

Editors' Summary: EPA imposes strict emissions and durability standards on vehicle manufacturers today. While these standards have become more stringent over time, the regulatory requirements for demonstrating compliance with these standards have relaxed. In this Article, Kevin L. Fast identifies and describes this relevant regulatory framework governing the reporting of emission-related component defects in North America. He provides descriptions and data on nearly 600 defect reports prepared by 6 of the largest vehicle manufacturers currently in the marketplace. Finally, he provides a comparative analysis linking the results of his data analysis to other regulatory programs for monitoring the in-use performance of motor vehicles.

I. Introduction

Today's motor vehicle manufacturers must design vehicles that are both low-emitting and durable. In North America, vehicles must now meet stringent Tier 2 emission standards, while in Europe, vehicles are subject to the new Euro IV emission standards. Not only do these stringent new emission standards require near-zero emissions in some cases, they also require that vehicles remain low-emitting for a longer portion of the vehicle's life cycle. In North America, for example, a typical light-duty vehicle must be designed to maintain low emissions for a period of 120,000 miles, while in Europe, similar vehicles must remain low-emitting for 100,000 kilometers (62,137 miles).

Interestingly, as the durability standards for motor vehicles have been extended to make them more stringent over time, the regulatory requirements for demonstrating adequate durability have been made less rigid and prescriptive. Before the last decade, regulatory programs required vehicle manufacturers to operate pre-production "prototype" vehicles for 50,000 miles (later extended to 100,000 miles) using a defined driving cycle to demonstrate that the vehicle would meet applicable emission standards for the vehicle's "useful life" and that the vehicle's emission control technology was sufficiently durable for that purpose. Today, by contrast, most manufacturers demonstrate durability using bench testing methods that focus almost exclusively on the vehicle's catalytic converter/oxygen sensor systems.[1] These bench testing methods simulate vehicle aging as a function of thermal deterioration of the converter/oxygen sensor systems. As to the durability of the vehicle's emission control system as a whole, i.e., that the system will not break and will operate as designed, manufacturers must demonstrate that the system and its component parts are sufficiently durable using "good engineering judgment."[2]

The U.S. Environmental Protection Agency (EPA) has recently described in general terms how vehicle manufacturers exercise good engineering judgment for this purpose. According to EPA, vehicle manufacturers evaluate a wide variety of different types of information, including information concerning real-world in-use experience, performance information on a supplier's products and the supplier's quality control practices, and computer modeling of design performance. Concerning actual physical testing of components, EPA has noted that it may make up only a small part, or no part at all, of the engineering evaluation.[3] To the same end, vehicle manufacturers have stated that they

> have in place rigorous validation processes to ensure the durability of components used in production vehicles. These widespread practices include the development of performance and design specifications that are furnished to part suppliers (and/or used in their own manufacturing processes); random sampling during the manufacturing process to assure compliance with design specifications; *in-use performance information on suppliers' products*;

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1. *See generally* 40 C.F.R. §86.1823-08 (2006).
2. *See* 71 Fed. Reg. 2810, 2821 (Jan. 17, 2006).
3. *Id.* at 2847.

review of suppliers' quality control practices; and computer modeling of design performance.[4]

Expanding upon the "in-use performance information" to which they refer, vehicle manufacturers maintain that "component durability is adequately addressed by other emissions compliance programs such as defect reporting, in-use testing, inspection and maintenance testing, and OBD [onboard diagnostics] reporting"[5]

The purpose of this Article is to provide an overview of one of the aforementioned categories of in-use performance information for motor vehicles—namely, emission-related component "defect reporting." The United States and Canada have long required that vehicle manufacturers report the occurrence of defects in the operation of emission control-related components. Based on a survey of defect reports submitted to EPA by a range of major vehicle manufacturers for recent model-year vehicles, this Article attempts to identify:

- The criteria used by vehicle manufacturers to identify "defective" emission-related components;
- The nature and frequency of defects discovered to exist for emission control components, including those arising in catalytic converters, oxygen sensors, and spark plugs; and
- The means by which vehicle manufacturers seek to remedy defects that have been reported to regulatory authorities.

To achieve these objectives, this Article first identifies and describes the relevant regulatory framework that governs the reporting of emission-related component defects in North America. Next, the Article provides a general description of nearly 600 defect reports prepared by 6 of the largest vehicle manufacturers currently in the marketplace obtained from EPA under the U.S Freedom of Information Act (FOIA). The description is followed by an analysis of the defect reports that addresses the three bulleted items listed above. The final sections provide a comparative analysis that links the results of the survey to other regulatory programs for monitoring the in-use performance of motor vehicles and a series of conclusions supported by the survey.

Ultimately, understanding how vehicle manufacturers assess the real-world durability of emission control system components has important implications that extend beyond vehicle design and production alone. For regulators interested in ensuring that vehicles operate properly in consumer use, knowing how manufacturers identify and repair or replace defective components may be essential to assessing whether or when to order vehicle recalls. For fuel producers interested in improving vehicle performance, knowing how manufacturers identify defective components may be essential to the design and production of better fuels. Finally, for consumers who bear most of the costs of defective components (at least those that may develop outside of any relevant warranty period), knowing how manufacturers identify and repair or replace defective components may be essential to protecting their rights as consumers.

4. U.S. EPA, Comments of the Alliance of Automobile Manufacturers and the Association of International Automobile Manufacturers, Public Air Docket No. OAR-2002-0079-0031.1 (2006) (emphasis added).

5. *Id.*

II. The Regulatory Framework

The United States and Canada have long required automakers to report the occurrence of defects in the operation of emission control-related components. The reporting requirements in the two countries are not identical, however. The criteria that govern when such reports must be submitted differ to some degree, as the sections below explain.[6]

A. Description of Defect Reporting Requirements

1. United States

In the United States, a manufacturer must file an emission-related defect report with EPA whenever the manufacturer learns that a "specific emission-related defect exists in twenty-five or more vehicles or engines of the same model year."[7] EPA's regulations define an "emission-related defect" to mean "a defect in design, materials, or workmanship in a device, system, or assembly described in the [vehicle manufacturer's] approved Application for Certification" that affect any of the following vehicle parameters or specifications.[8]

Basic Engine Parameters (Reciprocating)	Exhaust Emission Control System
Basic Engine Parameters (Rotary)	Evaporative Emission Control System
Air Inlet System	Crankcase Emission Control System
Fuel System	Auxiliary Emission Control Devices
Injection System	Emission Control-Related Warning System
Engine Cooling System	Driveline Parameters

A complete listing of the components covered in the foregoing list of parameters and specifications can be found in Appendix 1.

Defect reports must be submitted "not more than 15 working days after an emission-related defect is found" and must include the following information:

- The manufacturer's corporate name;
- A description of the defect;
- A description of each class or category of vehicles or engines potentially affected by the defect, including the number of vehicles or engines known or estimated to have the defect and an expla-

6. Information concerning the scope and implementation of the U.S. and Canadian defect reporting programs can be found in a wide range of publicly available sources including the following: (a) U.S. *Code of Federal Regulations*; (b) the U.S. *Federal Register*; (c) EPA rulemaking materials and guidance available at http://www.epa.gov; (d) the *Canada Gazette*; and (e) Canadian government rulemaking materials and guidance at http://www.transportcanada.gov or http://www.environmentcanada.gov. Relevant materials from these sources were surveyed to craft the descriptions of the in-use testing programs addressed in this study. Citations to the underlying sources have been provided, as appropriate.

7. 40 C.F.R. §85.1903(a)(2). EPA has indicated that it may revise the numerical threshold triggering the defect reporting requirement. *See* 71 Fed. Reg. 73884-85 (Dec. 11, 2006).

8. *See* 40 C.F.R. §85.1902(b).

nation of the means by which the number of defects was determined;

- An evaluation of the emissions impact of the defect and a description of any driveability problems that a defective vehicle might exhibit;
- Available emissions data which relate to the defect; and
- An indication of any anticipated manufacturer follow-up.[9]

If any of the required items of information are either (a) not available at the time a defect report is submitted to EPA, or (b) significantly revised, then manufacturers must submit additional information as it becomes available.[10]

2. Canada

Like the United States, Canada has required vehicle manufacturers to report defects in emission control system components for many years. Motor vehicle emission standards prescribed by Transport Canada under the Motor Vehicle Safety Act (MVSA) are designated as Canadian Motor Vehicle Safety Standards for the purpose of defect reporting under the MVSA.[11] This designation triggers, in turn, the obligation to report defects in emission control system components. More specifically, §10 of the MVSA provides that

> [a] company that manufactures, sells or imports any vehicle or equipment of a class for which standards are prescribed shall, on becoming aware of *a defect* in the design, construction, *or functioning of the vehicle or equipment* that affects or is likely to affect the safety of any person, cause notice of the defect to be given in the prescribed manner to (a) the Minister; (b) each person who has obtained such a vehicle or equipment from the company; and (c) each current owner of such a vehicle . . . .[12]

Similar to the U.S. defect reporting program, regulations issued by Transport Canada under the MVSA specify that defect reports must be in writing and shall indicate:

- The name of the company giving notice;
- The identifying classification of each vehicle in respect of which the notice is given, including its make, model, model year, vehicle identification number, and the period during which it was manufactured;
- The estimated percentage of the potentially affected vehicles that contain the defect;
- A description of the defect;
- An evaluation of the safety risk arising from the defect; and
- A statement of the measures to be taken to correct the defect.[13]

The responsibility for administration and enforcement of the vehicle defect reporting requirements of the MVSA as they relate to vehicle emission standards shifted to Environment Canada on March 31, 2000, pursuant to the Canadian Environmental Protection Act (CEPA) 1999.[14] In connection with this transfer of authority, Environment Canada stated that "the parts of the Motor Vehicle Safety Regulations that establish standards for automobile emissions remain in force until new regulations made under §160 of CEPA 1999 replace them."[15] Section 157 of CEPA 1999 contains a defect reporting requirement that is functionally equivalent to the reporting requirement established by §10 of the MVSA. The CEPA 1999 reporting requirement specifies that "[a] company that manufactures, sells, or imports any vehicle, engine or equipment of a class for which standards are prescribed shall, on becoming aware of *a defect* in the design, construction *or functioning* of the vehicle, engine or equipment that *affects or is likely to affect its compliance with a prescribed standard*, cause notice of the defect to be given in the prescribed manner . . . ."[16] The standards for vehicle emissions continued to be governed by the MVSA regulations until January 1, 2004, when new regulations under CEPA 1999 displaced the standards with new, more stringent, Tier 2 emission standards.[17]

B. In-Use Performance Criteria for Emission System Components

In parallel with the emission component-related defect reporting program, EPA also issued regulations in the mid-1990s, requiring vehicle manufacturers to equip their new vehicles with advanced on-board diagnostic (OBD) systems, known as OBD-II, to evaluate on a continuous basis the performance of various emission system components. As described by vehicle manufacturers, vehicle OBD systems are a "real time, full-time emission testing system" which provide an effective means to detect (and promptly repair) "vehicles with emissions equipment *not functioning as designed*."[18] OBD systems have been required on most light-duty vehicles in the United States since the 1996 model year and in Canada since the 1998 model year.[19] EPA requires the storage of diagnostic trouble codes (DTCs) and illumination of the OBD's malfunction indicator lamp (MIL) when the performance of various emission control system components degrade to specified degrees:

- **Catalytic converter:** Catalyst deterioration or malfunction before it results in an increase in non-methane hydrocarbon (NMHC) emissions exceeding 1.5 times the NMHC standard, as compared to the NMHC emission level measured using a representative 4,000 mile catalyst system.
- **Engine misfire:** Engine misfire resulting in exhaust emissions exceeding 1.5 times the applicable standard for NMHC, carbon monoxide (CO), or nitrogen oxides (NO_x) and any misfire capable of damaging the catalytic converter.

9. *Id.* §85.1903(c).
10. *Id.* §85.1903(b).
11. Motor Vehicle Safety Regulations §5(2)(b) (2004).
12. Motor Vehicle Safety Act, R.S.C., ch. 16, §10 (2004) (Can.) (emphasis added).
13. Motor Vehicle Safety Regulations §15(1).
14. *See* Environment Canada, *Environmental Acts and Regulations*, http://www.ec.gc.ca/EnviroRegs/Eng/SearchDetail.cfm?intAct=1048 (last visited Mar. 1, 2007).
15. *Id.*
16. Canadian Environmental Protection Act, 1999, R.S.C., ch. 33, §157(1) (1999) (Can.) (emphasis added).
17. C. Gaz., Part II, Vol. 137, No. 1, 10 (Jan. 1, 2003).
18. U.S. EPA, Comments of the Alliance of Automobile Manufacturers, Public Air Docket No. A-2000-16, IV-D-03, Enclosure (Oct. 13, 2000) (emphasis added).
19. *See* 40 C.F.R. §86.094-17; C. Gaz., Part II, Vol. 131, No. 172419.

- **Oxygen sensors:** If equipped, oxygen sensor deterioration or malfunction resulting in exhaust emissions exceeding 1.5 times the applicable standard for NMHC, CO, or NO_x.
- **Evaporative leaks:** If equipped, any vapor leak in the evaporative and/or refueling systems greater than or equal in magnitude to a leak caused by a 0.040-inch-diameter orifice.
- **Other emission control systems:** Any deterioration or malfunction occurring in a powertrain system or component directly intended to control emissions singularly resulting in exhaust emissions exceeding 1.5 times the applicable emission standards for NMHC, CO, or NO_x.
- **Other emission-related powertrain components:** Any deterioration or malfunction occurring in an electronic emission-related powertrain system or component that either provides input to or receives commands from the OBD computer and has a measurable impact on emissions.
- **Performance of OBD functions:** Oxygen sensor or any other component deterioration or malfunction which renders that sensor or component incapable of performing its function as part of the OBD system must be detected and identified on vehicles so equipped.[20]

MIL illumination on the vehicle's dashboard alerts the driver that maintenance is necessary to repair or replace engine or emission system components. The vehicle's onboard computer stores DTCs, which identify the degraded component or components that are in need of service or replacement. Prompt repair of the vehicle ensures that vehicle emissions remain at acceptable levels.

III. Assessment of Emission-Related Defect Reports Obtained Via FOIA

The objective of this Article is to better understand how vehicle manufacturers implement the emission-related component defect reporting program as it relates to assessing the performance of emission system components in consumer use. For this purpose, requests under FOIA[21] were prepared and submitted to EPA seeking defect reports sent to EPA in recent years by several major vehicle manufacturers and any of their affiliated companies. The targeted automakers were American Honda Motor Co., Inc. (Honda), DaimlerChrysler Corporation (DaimlerChrysler), Ford Motor Company (Ford); General Motors Corporation (General Motors), Toyota Motor Corporation (Toyota), and Volkswagen of America, Inc. (Volkswagen). EPA released two categories of information in response to the FOIA requests: (1) detailed Excel® spreadsheets summarizing the defect reports received by EPA by some of the vehicle manufacturers, i.e., Ford, General Motors, and Honda; and (2) the actual defect reports submitted by vehicle manufacturers for a broad subset of the total set of defect reports submitted by the six different manufacturers.[22]

For each defect report submitted by a vehicle manufacturer, EPA designates a unique EPA reference number. Table 1 below summarizes the number of individual EPA reference numbers assigned to the defect reports prepared by each vehicle manufacturer for 2001 and later model-year vehicles through March 31, 2006 (unless otherwise noted).

Table 1

Vehicle Manufacturer	Number of Reported Defects
DaimlerChrysler	71
Ford Motor Company	185
General Motors	60
Honda	117
Toyota	53
Volkswagen[23]	68
Total	**554**

Importantly, the assigned EPA reference number can apply either to a defect that has arisen in a single make and model year of the vehicle manufacturer's production line, or alternatively, can apply to multiple makes and model years where the defect arises on a broader scale, both quantitatively and temporally. Table 2 below provides examples on either end of the spectrum for each vehicle manufacturer.

20. *See generally* 40 C.F.R. §86.1806-05.

21. 5 U.S.C. §552, *available in* ELR Stat. Admin. Proc.

22. The defect reports obtained from EPA are comprised of thousands of pages of material. For this reason, including the individual defect reports as appendices to this study is simply not feasible. Copies of the defect reports obtained from EPA remain in the possession of the author.

23. Defects submitted through Dec. 31, 2005.

Table 2

Vehicle Manufacturer and EPA Reference Number	Model(s)	Model Year(s)	Number of Potentially Affected Vehicles
DaimlerChrysler			
#2701	PT Cruiser	2006	61
#2481	Dakota, Ram Pickup, Pacifica, Durango, Liberty, Concorde, LHS, Intrepid, 300M, Prowler, Minivan, Viper, Wrangler, Grand Cherokee	2001 2002 2003 2004	3,830,456
Ford Motor Company			
#2287	E-Series Trucks	2001	840
#2338	Lincoln LS, T-Bird, Crown Victoria, Grand Marquis, Town Car, Aviator, F-Series Trucks	2003 2004	462,200
General Motors			
#1653	Saturn	2001	98
#2388	Venture, Montana, Aztek, Silhouette, Malibu, Lumina, Impala, Monte Carlo, Camaro, Grand Prix, Firebird, Bonneville, Alero, Century, Regal, Park Avenue, Grand Am	2001	1,094,266
Honda			
#1924	NSX	2001	167
#2227	Accord, MDX, TSX, Element, TL	2003 2004	799,682
Toyota Motor Corporation			
#2188	Prius	2004	3,500
#2264	Camry, Solara	2002 2003 2004	783,586
Volkswagen			
#1905	Bentley Arnage	2002	218
#1975	New Beetle, Golf, Jetta, Passat, EuroVan, GTI, Cabrio, Quattro	2001 2002 2003	455,199

Collectively, the defect reports prepared by the listed vehicle manufacturers and released by EPA in response to FOIA requests list millions of potentially affected 2001 and later model-year vehicles in consumer use.

The information released by EPA in response to FOIA requests was assessed to answer the following technical questions:

1. On what basis do vehicle manufacturers identify defective emission-related components?
2. Are changes in vehicle emissions relevant to identifying defective emission-related components and, if so, how?
3. Once a defective component has been identified, what action, if any, do vehicle manufacturers undertake to remedy the defect?
4. How frequently are major emission control components, such as catalytic converters or oxygen sensors, found to be defective?

Answers to each of these questions are provided separately below.

A. Criteria for Identifying Defective Emission-Related Components

Automakers identify emission-related component defects in a number of different ways. The two most common means are consumer complaints (usually about vehicle driveability) and OBD MIL illumination. Between the two, however, the survey of defect reports suggests that OBD MIL illumination is by far the most common means of identifying failed or defective emission-related components.

1. OBD System Operation

The vehicle manufacturers surveyed universally relied upon the vehicle's OBD system for the purpose of identifying defective emission-related components. This is hardly a surprising result given that EPA's OBD system requirements specify detailed criteria for measuring whether emission-related components are performing adequately in consumer use. Table 3 provides illustrative examples of defect reports from the surveyed vehicle manufacturers which confirm widespread reliance upon the vehicle's OBD system. (References to OBD MIL illumination are highlighted.)[24]

24. The quoted text in each row of Table 3 was obtained directly from the defect reports to which EPA assigned the listed reference number in column two of the table. Highlights to the quoted text have been added by the author.

Table 3

Vehicle Manufacturer	EPA #	Nature of Defect	Relevance of OBD?
DaimlerChrysler	2113	"Some 2003 Model Year Chrysler Voyager, Town and Country and Dodge Caravan vehicles may exhibit rough/fluctuating idle or no-start conditions below 32 degrees Fahrenheit and MIL illumination of Diagnostic Trouble Codes P0508/P0509 . . . due to a failed network resistor within the Powertrain Control Module (PCM)."	"A Technical Service Bulletin (TSB) (18-022-03) has been released that addresses the hardware and MIL issues. Should the vehicle exhibit driveability symptoms *and MIL illumination associated with this issue*, the vehicle will be returned to the dealer where the PCM will be replaced. No further action is anticipated."
Ford	2526	"Some 2004 model 6.8L E-series trucks may have Fuel Delivery Module seizure due to fuel tank contamination resulting in fuel pump damage."	"Ford judges that exhaust standards may be exceeded if this condition is present. If this condition is present, the engine may experience one or more of the following: lack of power, hesitation, stalling, no start, *the Onboard Diagnostic System will store a fault code and the Malfunction Indicator will be illuminated*. This concern will cause the operator to obtain service for the vehicle."
General Motors	2167	"Some spark plugs were produced with inadequate center electrode powder fill. This may result in voids in the conductive path inside the spark plug, leading to internal micro arcing and misfire."	"There is no significant impact on emissions anticipated. If an engine has spark plugs with inadequate electrode powder fill, there will be obvious overt indications to the customer when the spark plugs are not functioning properly. *There will be illumination of the Malfunction Indicator Lamp (MIL)* and ignition misfire."
Honda	2619	"The electrical terminal of automatic transmission shift solenoid (A) may short circuit due to erroneous metal contaminating the terminal area. The MIL illuminates."	"When this defect occurs, *the MIL illuminates*, the vehicle will likely be brought to a dealership and repaired under emission warranty."
Toyota	2020	"MIL illumination with code (P0136) due to rear oxygen sensor concern."	"Emissions Impact: None, *the OBD system will immediately detect with MIL illumination*."
Volkswagen	1975	"One or more of the vehicle's individual cylinder ignition coil(s) may become inoperable causing the engine to misfire and illumate the Malfunction Indicator Lamp (MIL)."	"Based on the fact that vehicles effected by the mentioned defect have generally exhibited this problem early in the vehicle's useful life, on average 14 months in service, and the driver of a mentioned vehicle is clearly made aware that an engine problem exists through *illumination of the MIL* and decreased engine performance, it is unlikely that a vehicle will be operated for a time period long enough to make a major emissions impact."

In addition to OBD MIL illumination and the presence of DTCs, vehicle manufacturers also rely upon customer complaints regarding vehicle performance or driveability as potential clues leading to the identification of defects. In some cases, for example, the reported defects pertain to the operation of the vehicle's OBD system itself, in which case reliance upon the OBD system for the identification of the defect may not be appropriate.[25]

2. Vehicle Emissions

As noted above, EPA's defect reporting regulations require vehicle manufacturers to submit to EPA any "available emissions data which relate to the defect." A review of the defect reports failed to reveal any consistent approaches either to the generation of emission data by vehicle manufacturers or the submission of such data to EPA. Nor does it appear that EPA has adopted a consistent approach regarding emission data and its relationship to the identification and repair of defective emission-related components.

The defect reports submitted by Volkswagen and Toyota provide a good illustration of the starkly different approaches automakers have adopted with respect to the generation and reporting of emission data. Table 4 below lists the frequency that Volkswagen and Toyota generated emission data for submission to EPA as part of their respective sets of defect reports.

Table 4

Vehicle Manufacturer	# of Defect Reports	# Reporting Emission Data	Percentage
Volkswagen	68	34	50%
Toyota	53	5	9%

Although the two manufacturers submitted roughly the same number of defect reports to EPA, Volkswagen generated far more emission data as part of those reports—both in absolute terms (by about a factor of six) and as a percentage of the total number of reports submitted to EPA (by about a factor of five).

25. *See infra* Part III.A.2.

The two vehicle manufacturers also appear to have different views regarding the extent to which a defect impacts emissions. As illustrated in Table 5 below, Toyota repeatedly states that the reported defect will not impact emissions because the OBD system will detect the defect, irrespective of the nature of the defect.[26]

Table 5

Defect Report	Nature of Defect	Emission Impact
EPA #2020	Rear oxygen sensor	"None, the OBD system will immediately detect with OBD illumination."
EPA #2121	Throttle body motor	"None, the OBD system will immediately detect with a MIL illumination."
EPA #2226	Evaporative control system leak	"None. This condition will be detected by the OBD system."
EPA #2264	Catalytic converter performance due to misfire	"None, [t]his condition will be detected by the OBD system."
EPA #2517	Catalytic converter	"None. This condition will be detected by the OBD system."
EPA #2682	Oxygen sensor	"Since the OBD-II system identifies this malfunction, the impact on emissions is judged to be minimal."

Table 6 lists the two emission-related component defects for which Toyota actually reported emission data.[27]

Table 6

Defect Report	Nature of Defect	Emission Impact
EPA #2178 #2381 #2411	Idle Air Control Valve Sticking	"As can be seen, the NMHC is somewhat higher but still below the standard. CO and NO_x results are well below the applicable standards. Consequently, we judged no immediate remedial action is required at this time."
EPA #2190 #2294 #2401	Cracked exhaust manifold	"Results in chart below show minimal effect on emissions."

A closer review of the defect reports listed in Table 6 reveals several interesting facts. First, in the case of the idle air control valve defect, Toyota tested the defective component on a 1999 Lexus ES300, even though the defect was reported to have occurred in three different models in later model years: (1) the 2001 Highlander; (2) the 2002 and 2003 RX300; and (3) the 2002 and 2003 Sienna. Toyota provides no explanation as to why testing a 1999 Lexus ES300 should be deemed sufficient to measure the impact of the defective component on emissions on different model groups in later model years. (One possible explanation may be that the 1999 Lexus ES300 is representative of the 2001 through 2003 model-year vehicles because it is in the same durability group as the later model-year vehicles.) Nor does Toyota explain why the defective component can be tested in isolation, separate from the vehicle on which the defect was found. Such an approach may understate the impact of a defective component on vehicle emissions since it is generally accepted (and expressly recognized in EPA's OBD regulations) that a defect in one component, e.g., spark plugs, can cause degradation in another component (such as the catalytic converter).[28]

Second, the emissions deemed by Toyota to be "somewhat higher" in defect reports numbers 2178, 2381, and 2411 were actually as much as 59% higher than emissions with the nondefective mode of operation. As Toyota correctly notes, however, the higher emissions were still below the standard, i.e., 0.073 gram per mile compared to the 0.075-gram-per-mile standard. This characterization of the emission data by Toyota suggests that Toyota interprets changes in emissions caused by component degradation to be unimportant unless those changes cause the vehicle to fail one or more applicable in-use emission standards.

Third, in the case of the exhaust manifold defect, Toyota reports that "[a] cracked manifold recovered from the field parts was evaluated on [the] Japanese 10-15 and 11 mode."[29] Toyota reported the noted defect to have occurred in four different model groups: (1) the 2001 Sequoia; (2) the 2001 Tundra; (3) the 2001 Landcruiser; and (4) the 2001 LX470. Nonetheless, the emission data reported for each model is the exactly the same. Toyota does not identify what type of vehicle was used to assess the emission impact of the defect, why testing only one vehicle (assuming that is what Toyota did) should be sufficient to gauge the effect on emissions in the other vehicles, or why using the Japanese 10-15 and 11 mode should be deemed to be the equivalent to EPA's official emission testing cycles, i.e., the Federal Test Procedure (FTP) and Supplemental Federal Test Procedure (SFTP).

In contrast to Toyota, Volkswagen's assessment of impacts on emissions is a bit more complex, if for no other reason than Volkswagen conducted emission testing more frequently than Toyota (at least based on the sample of defect reports obtained from EPA). Table 7 lists an illustrative subset of defect reports submitted to EPA by Volkswagen that contain emission data.[30]

26. The quoted text in each row of Table 5 was obtained directly from the defect reports to which EPA assigned the listed reference number in column one of the table.

27. In both cases, Toyota discovered the defect in several different model groups, which prompted Toyota to submit to EPA multiple defect reports for the same defect. Table 6 lists the relevant EPA reference numbers. The quoted text in each row of Table 6 was obtained directly from the defect reports to which EPA assigned the listed reference number in column one of the table.

28. *See, e.g.*, 40 C.F.R. §86.1806-05(b)(2) (referring to "any misfire capable of damaging the catalytic converter").

29. Toyota Defect Reports, EPA Reference Numbers 2190, 2294, and 2401.

30. The quoted text in each row of Table 7 was obtained directly from the defect reports to which EPA assigned the listed reference number in column one of the table.

Table 7

Defect Report	**Nature of Defect**	**Emission Impact**
EPA #1765	Loose or cracked vacuum diaphragm	"Five vehicles were tested to determine the effect of failures upon emissions. . . ."
EPA #1806	Blown fuse in secondary air injection system	"The secondary air pump was disconnected to simulate a blown fuse on the secondary air pump. The test vehicle was beyond the product change."
EPA #1872	Air Pump	"The secondary air pump was disconnected to simulate a blown fuse on the secondary air pump."
EPA #1873	Oxygen sensor	"10 random sample parts (with related DTC codes) were installed on test vehicle and driven up to 1000 miles with no recorded DTC faults and no MIL illuminated during the test drive. FTP tests were then performed using the test vehicle and two of the sample parts to determine if an emissions impact existed using these suspected sample warranty parts. Both tests showed no emissions impact."
EPA #2063	Leaking catalytic converter	"3.0L Audi vehicles were emission tested with improper welds at the converter housing. The NMHC figures were slightly above the Emission Standards due to the false signal read by the oxygen sensor."
EPA #2490	Catalytic converter and misfire	"68% of components analyzed showed no fault with the catalytic converter itself. Further system analysis showed that the current OBD strategy for catalytic converter efficiency MIL illumination is too sensitive . . . Emission test results of 68% of sample catalytic converters without melted monoliths showed no emissions related impact."
EPA #2627	Faulty turbo bypass valve	"Test vehicle was within given emission standards."

As with the Toyota defect reports, a closer review reveals some interesting facts that highlight both similarities to, and differences with, the Toyota approach. First, unlike Toyota, some of the testing conducted by Volkswagen involves testing on one or more vehicles with a simulation of the defect, rather than the actual defect (EPA Reference Numbers 1806 and 1872). Simulations of the sort described by Volkswagen necessarily ignore the possibility of collateral impacts the failed component might have had on other emission system components. As the simulated approach did not engender any negative reaction from EPA (at least on the face of the reports), it is apparently an acceptable approach for measuring the impact of defects on vehicle emissions.

Second, Volkswagen does not adopt a consistent approach for measuring the emission impact of a defect. In some cases, Volkswagen opted to test multiple vehicles and present the average emissions for the set of tests, i.e., EPA Reference Numbers 1873 and 2490, while in other cases, Volkswagen opted to test a single vehicle, i.e., EPA Reference Number 2627.

Third, like Toyota, the defect reports submitted by Volkswagen express the view that a defective component does not impact emissions unless it exceeds applicable standards. A good example is EPA defect report, Reference Number 1873. In that report, Volkswagen asserts that the defective oxygen sensors tested showed no emissions impact even though average emissions with the defective parts showed an across-the-board increase in emissions of as much as 61, 21, and 148%, respectively, for the three regulated pollutants. Another example is EPA defect report, Reference Number 2627, where emissions increased at a more modest 3 to 27% range. A mixed example, i.e., some pollutant emissions increasing substantially and some decreasing, can be found in EPA report, Reference Number 1806, where emissions dropped for one regulated pollutant, but increased by 148 and 184% for the other two pollutants compared to the reported baseline emissions.

Fourth, like Toyota, Volkswagen expressly lists OBD thresholds as applicable standards for assessing the performance of emission-related components. In EPA report, Reference Number 2490, for example, Volkswagen lists the applicable OBD thresholds, noting that its field testing shows that "the OBD strategy" at issue "is too sensitive."[31] This implies that not all occurrences of OBD MIL illumination necessarily mean that converters or other components have failed. Vehicle manufacturers clearly rely on field testing of the sort identified in EPA report, Reference Number 2490 to validate and refine OBD strategies.

Finally, with respect to both Toyota and Volkswagen defect reports, the assessment of the emission data by EPA is generally inconsistent. For each defect report, EPA completes a voluntary emission recall report (VERR) Review Checklist. (A representative copy of the EPA checklist is contained in Appendix 2.) Among the items to be completed on the checklist is a designation of the defect's emissions impact. EPA's choices are "major," "minor," or "none." When the vehicle manufacturer reports that the defect results in emissions that exceed standards (whether measured on average or otherwise), EPA typically designates the emission impact of the defect to be major. On the other hand, when a vehicle manufacturer reports an increase in emissions that remains below the applicable emission standards, EPA typically designates the emission impact to be minor, even if the relative increase in emissions is large. The inconsistency arises with respect to reliance upon the vehicle's OBD system. In Table 5, above, Toyota asserted that the emission impact of all but one of the listed defects is "none" because the vehicle's OBD system would detect the defect. EPA accepted this characterization for each of the listed defect reports prepared by Toyota, checking the entry as none on the associated VERR Review Checklist. EPA chose this characterization of the emission impact of the defects notwithstanding that the threshold for OBD MIL illumination may be higher, in fact, than the applicable FTP- or SFTP-based in-use emission standards.

31. Volkswagen Defect Report, EPA Reference Number 2490.

B. Automaker Action in Response to Defective Components

EPA publishes annual recall lists on its website.[32] EPA's annual recall reports identify the vehicle manufacturers who conducted the recalls (listed as ordered, influenced, or voluntary), the make and model years of vehicles in the recall campaigns, and the nature of the defect that prompted the recall. EPA's recall reports also include the specific EPA reference number given to the defect report that ultimately prompted the recall. As a result, the list of defect reports received from EPA in response to the FOIA requests described above and the recalls that occurred for all 2001 and later model-year vehicles can be cross-referenced to determine the relative frequency that recalls occur for defective emission-related components.

Table 8 lists the percentage of defect reports received from EPA in response to FOIA requests for each vehicle manufacturer that were also the subject of an ordered or voluntary recall campaign.[33]

Table 8

Vehicle Manufacturer	**# of Reported Defects**	**# Subject to Recall**	**Percentage**
DaimlerChrysler	71	21	30%
Ford Motor Company	185	9	5%
General Motors	60	5	8%
Honda	117	20	17%
Toyota	53	10	19%
Volkswagen	68	12	18%
Total	**554**	**77**	**14%**

Overall, vehicle manufacturers conducted a recall to address a reported defect in approximately 14% of the cases, although the relative frequency varied by as much as a factor of six from one vehicle manufacturer to the next. This cross-checking exercise suggests that vehicle manufacturers typically do not recall vehicles for the repair of defective emission-related components. While recalls do occur from time to time, the far more prevalent response is to rely on the vehicle's OBD system to alert the vehicle's owner when repairs are needed. As shown in Table 3, every vehicle manufacturer surveyed preferred the self-policing approach that reliance upon the vehicle's OBD system provides for detecting and prompting repair of emission-related component defects.

C. Emission-Related Component Defects by Category

Table 9 provides a general description of the defect reports obtained from EPA in response to FOIA requests. Six component categories are presented: (1) catalytic converter; (2) oxygen sensor; (3) spark plugs/misfire; (4) OBD system/calibration; (5) other; (6) and labeling. The OBD system/calibration category includes any defects in the software codes governing vehicle operation or OBD system operation. The "other" category includes any components not otherwise listed, e.g., fuel injectors, intake manifolds, hoses, valves, sensors, transmission, or miscellaneous gaskets not linked to any other listed components, etc.[34]

32. *See* U.S. EPA, *Cars and Light Trucks: Vehicle Recalls*, http://www.epa.gov/otaq/recall.htm (last visited Mar. 1, 2007).

33. EPA's recall reports include several EPA reference numbers for defects apparently reported by the targeted automakers, but not disclosed by EPA in response to FOIA requests seeking *all* defect reports submitted by the targeted automakers. The undisclosed defect reports listed in EPA's recall reports have not been incorporated into this study. Why EPA failed to report all relevant defect reports is not known. The existence of an undisclosed number of defect reports necessarily means, however, that the results presented in this study: (1) understate to some degree the frequency and scope of defect reporting by the targeted automakers; and (2) should be interpreted as suggestive of the defect reporting practices of the targeted automakers rather than an exhaustive recitation of those practices.

34. While most defect reports fall readily within one of the six categories, some might reasonably be allocated to more than one category, particularly in the case of some defect reports potentially falling into the OBD/Calibration category. If the remedy for the defect involved alteration to a listed component (as well as calibration changes), the defect was allocated to the individual component category.

Table 9

Manufacturer	**Catalyst**	**O_2**	**Misfire**	**OBD/Calibration**	**Other**	**Labeling**	**Total**
DaimlerChrysler	0	4	4	20	32	11	71
Ford	6	6	7	60	102	4	185
GM	0	1	3	41	15	0	60
Honda	5	2	7	67	36	0	117
Toyota	7	5	4	15	19	3	53
VW	5	5	6	11	37	4	68
Total	**23**	**23**	**31**	**214**	**241**	**22**	**554**
% Total	**4%**	**4%**	**6%**	**39%**	**44%**	**4%**	**--**

The foregoing table makes abundantly apparent that the single most frequently reported defect is one pertaining to software coding for either the vehicle's calibration or the OBD system. By contrast, defects in major emission system components, such as the catalytic converter or oxygen sensors, occur far less frequently, albeit still making up approximately 5% of the total in each instance.

When viewed as a percentage of the total defect reports submitted by each vehicle manufacturer as set forth in Table 10, the picture is much the same.

Table 10

Manufacturer	**Catalyst**	**O_2**	**Misfire**	**OBD/Calibration**	**Other**	**Labeling**
DaimlerChrysler	0	6%	6%	28%	45%	15%
Ford	3%	3%	4%	32%	55%	2%
GM	0	2%	5%	68%	25%	0
Honda	4%	2%	6%	57%	31%	0
Toyota	13%	9%	8%	28%	36%	6%
VW	7%	7%	10%	16%	54%	6%
Overall %	**4%**	**4%**	**6%**	**39%**	**44%**	**4%**

As with the overall totals, each vehicle manufacturer reported a substantial number of defect reports for problems in software coding for vehicle calibration or OBD system operation. In four respects, however, the experience of individual vehicle manufacturers appears to be notably different from the other automakers.

- DaimlerChrysler and General Motors do not report any defects in catalytic converters.
- General Motors and Honda appear to experience far more defects in the software coding of vehicle calibrations or OBD systems relative to the other manufacturers, i.e., by a factor of about two or more.
- In the opposite respect, Volkswagen appears to report far fewer software coding problems—again by about a factor of two or more relative to the other manufacturers.
- For reasons that are not clear, Toyota and Volkswagen have reported relatively more problems with catalytic converter, oxygen sensor, and spark plug operation than the other automakers.

A final series of results pertains to the specific nature and scope of the reported problems associated with the operation of three key components of modern vehicle emission control systems: (1) catalytic converters; (2) oxygen sensors; and (3) spark plugs. Catalytic converters and oxygen sensors—together with the vehicle's on-board computer—continue to be the most essential hardware for achieving the simultaneous reduction of NMHC, CO, and NO_x made necessary by today's stringent emission control standards.[35] Spark plugs, on the other hand, do not assist in the control of vehicle emissions in any direct sense, other than as a means for achieving more complete combustion, but their effective operation is essential for maintaining the proper operation of catalytic converters and oxygen sensors, as EPA's regulations expressly recognize.[36] For these reasons, Tables 11 through 13 list the reported defects by each automaker for each of these individual emission-related components, showing the specific vehicles and model years affected, the nature of the defect, and how the defect was remedied. (Tables 11 through 13 can be found in Appendix 3.)

35. *See* 69 Fed. Reg. 17532, 17536 (Apr. 2, 2004).

36. *See* 40 C.F.R. §86.1806-05(b)(2).

Tables 11 through 13 are notable in several respects. First, the number of reported defects for the three components appears to be substantial. Millions of 2001 and later model-year vehicles in consumer use are potentially affected by defects that have been reported for one or more of these components. Table 14 summarizes what is depicted in more detail in Tables 11-13.

Table 14

Emission Related Component	Reported Number of Potentially Affected Vehicles
Catalytic Converter	3,136,330
Oxygen Sensors	1,878,088
Spark Plugs	3,068,315

Although the reported defects may not arise in every potentially affected vehicle, the sheer magnitude of the vehicles potentially affected means that tens of thousands or hundreds of thousands of vehicles will be impacted even if only a fraction of the vehicles encounter the defect.

Second, recalibration of the vehicle's on-board computer is, by far, the most frequent remedy identified for defective catalytic converters, oxygen sensors, and spark plugs—whether viewed individually or collectively as a group of components. (In some cases, the reported remedy may involve the combination of one or more of the noted categories of action, e.g., an improved component plus recalibration of some sort. This finding is consistent with the observation noted above that recalibration is the most commonly reported remedy for defective components considered in their entirety.) Table 15 summarizes the nature of the remedy for each of the three components.

Table 15

Component	Number of Reported Defects	Remedy				
		Improved Component	Replaced Component	Recalibration	Other Hardware	Unknown
Converters	23	3	4	7	3	8
O_2 Sensors	23	6	2	7	4	5
Spark Plugs	31	3	2	9	7	11
Total	**77**	**12**	**8**	**23**	**14**	**24**

Recalibration is involved in nearly 50% of the listed defects where the remedy is otherwise specified.[37] Somewhat surprisingly, improved components are listed as the remedy in only about one-quarter of the cases that include a specified remedy.

Third, Tables 11 through 13 make clear that the vast majority of defects in emission-related components arise as a result of vehicle design- or build-related problems. Of the 75 defects shown in Tables 11 through 13, only a very small fraction (in each case, less than 10%) can be linked in any way to variables over which the vehicle manufacturer may have little control—namely: (1) how the consumer operates the vehicle in-use; (2) fuel quality; or (3) geographic/weather-related variables. Table 16 below identifies the subset of defect reports that may be linked in some fashion to one or more of the noted variables.[38]

Table 16

Consumer Use-Related	Fuel Quality	Weather/Geography
Honda/#2477 ("specific limited driving conditions")	Ford/#1768 ("high aromatic content premium fuels")	Ford/#1639 ("low ambient temperatures")
Ford/#2403 ("frequently running in go-and-stop mode")	General Motors/ #1844 ("alcohol content of the fuel")	Ford/#2134 ("air conditioning condensate")
Ford/#2471 ("frequently running in go-and-stop mode")	Toyota/#1575 ("low RVP fuel")	Toyota/#2189 ("high humidity areas")
Ford/#2472 ("parked and the engine is operated at high RPMs")	Toyota/#1903 ("low RVP fuel")	Toyota/#2412 ("high humidity areas")
Toyota/#2264 ("light engine load conditions")	Toyota/#2116 ("low volatile fuel")	Toyota/#2607 ("high humidity areas")
Toyota/#2516 ("light load conditions")	Volkswagen/#1973 ("fuel quality")	Toyota/#2682 ("high humidity areas")
	Volkswagen/#2045 ("fuel quality")	Volkswagen/#1693 and 1805 ("cold and damp ambient conditions")

37. It is clear from the description of several of the reported defects in Tables 11 through 13 where a remedy is not otherwise specified that the "fix" involved some sort of recalibration. Those cases are nonetheless included in the "unknown" category.

38. The quoted text in each row of Table 16 was obtained directly from the defect reports to which EPA assigned the listed reference numbers which are also shown in the table.

D. The Frequency of Emission-Related Component Defects

The actual number of vehicles that are impacted by a defective emission-related component cannot be discerned from a review of the defect reports, except for those that involved a recall (in which case automakers ideally repair all or most of the vehicles in the affected model groups). The inability to discern the precise number of defects follows from the fact that most defect reports state that the defect will be identified by the vehicle's OBD system and repaired. The defect reports do not typically project or predict the total number of defects likely to be encountered, as a comparison of the defect reports submitted by Toyota and Volkswagen makes apparent.

The Toyota and Volkswagen defect reports illustrate the extent to which automakers appear to interpret differently their obligation to report the number of vehicles known or estimated to have the defect reported to EPA. Table 17 shows the number of defect reports that contain information about the defects known or estimated to exist at the time the report was submitted to EPA.

Table 17

Vehicle Manufacturer	**# of Defect Reports**	**# Reporting Known or Estimated Number of Defects**	**Percentage**
Volkswagen	68	66	97%
Toyota	53	14	26%

In the case of Toyota, the 14 cases where they reported the known or estimated number of defects involved some sort of recall campaign or special service campaign which, by their nature, targeted all of the vehicles identified as potentially affected. None of the remaining defect reports provide any information as to the specific number of defects experienced by Toyota vehicles at any particular point in time. More often than not, the Toyota defect reports state only that some vehicles in the affected vehicle group have or will experience the defect.

The approach adopted by Volkswagen is strikingly different. In nearly every case, Volkswagen reported to EPA detailed information concerning the number of defects experienced by Volkswagen vehicles at the time of the submission. This information typically involved warranty-related information reported by Volkswagen. In some cases, only a few instances of a defect are reported for a particular vehicle and model year, e.g., EPA Reference Number 2639, while in other cases, tens of thousands of defects might be reported, e.g., EPA Reference Number 2319.

The other automakers generally follow either the Toyota or Volkswagen approach. Like Toyota, DaimlerChrysler, Ford, and General Motors generally did not report specific information on the number of defects encountered in the field. Honda, on the other hand, followed the Volkswagen approach, but to a lesser degree.

Where warranty or other similar data are available, the defect reports typically show an increasing number of warranty repairs as the vehicles in the affected group age, i.e., as they accumulate mileage in consumer use. For example, Honda reported that "the exhaust manifold with close-coupled catalyst may crack due to repeated exposure to excessive thermal stress" on the Civics it manufactured in the 2001 through 2004 model years.[39] Table 18 reproduces the frequency information contained in the relevant EPA defect report, Reference Number 2473).

Table 18

The following is the number of vehicles estimated to have the defect based on the number of exhaust manifold related warranty and total production.		
Test Group	Production	Exhaust Manifold-Related Warranty
1HNXV01.7YJ9	200074	299
2HNXV01.7TA5	170480	99
3HNXV01.7WA5	147827	2
4HNXV01.7WA6	156776	0

Although the absolute number of cracked manifolds is modest, the relative change in the number of claims from one model year to the next is substantial. Warranty claims related to the cracked manifold increased by a factor of nearly 50 from model year 2003 to model year 2002, and increased by another factor of three from model year 2002 to 2001. Comparing the claims for model year 2003 to the claims for model year 2001, the claims for the 2001 model year are 150-fold higher than those for the 2003 model year. This pattern clearly suggests that the exhaust manifold defect is linked to the age of the vehicle—namely, as the vehicles age, they are more likely to encounter the defect.

Honda did not conduct a recall to address the problem of cracked manifolds in 2001-2004 Civics. Instead, Honda's defect report states that "[a]s the crack develops, exhaust noise becomes audible that the vehicle owner will likely notice and the vehicle will be brought to the dealership and diagnosed under emission warranty."[40] Since EPA accepted the "self-policing" nature of the problem, the full extent of the problem cannot be discerned from defect report, Reference Number 2473.

Another defect report submitted by Honda further illustrates the age-related link between the reported defect and warranty claims (albeit somewhat differently). In defect report, Reference Number 2474, Honda reported another emission-related component defect in 2001 through 2003 Civics. Honda reported that "[t]he flow of some fuel injectors may decrease due to the contamination during the manufacturing process. The MIL illuminates for misfire." Table 19 reproduces the frequency information contained in defect report, Reference Number 2474.

39. Honda Defect Report, EPA Reference Number 2473.

40. *Id.*

Table 19

The following is the number of vehicles estimated to have the defect based on the number of confirmed MIL illumination due to the defective injector and total production.		
Test Group	Production	Confirmed MIL Illumination Due to Defective Injector
1HNXV01.7RJ9	2850	(01M total)
1HNXV01.7XJ9	111479	67
1HNXV01.7YJ9	200074	
2HNXV01.73A5	1500	(02M total)
2HNXV01.7NA5	145756	76
2HNXV01.7TA5	170480	
3HNXV01.72A5	1035	(03M total)
3HNXV01.7VA5	107940	24
3HNXV01.7WA5	147827	

As with the defective exhaust manifold, warranty claims for the most recent model year are lower than the claims for older model years. Warranty claims for the 2001 and 2002 model-year Civics are approximately three times greater than the claims for the 2003 model year. In contrast to the defective exhaust manifold, however, the number of warranty claims for the defective fuel injectors are roughly the same for model years 2001 and 2002, i.e., occurring once in every 4,000 to 5,000 vehicles.

Ultimately, as with the defective exhaust manifold, the total number of fuel injector defects cannot be discerned from defect report, Reference Number 2474. Rather than conduct a recall, Honda indicated that the "[m]anufacturing process of injectors has been improved to prevent contamination. When the MIL illuminates, the vehicle will likely be brought to a dealership and diagnosed under emission warranty."[41] How many defective fuel injectors have been replaced due to MIL illumination is not reported in defect report, Reference Number 2474.

In short, the defect reports typically provide no basis to assess how extensively a defect may be encountered by vehicles in consumer use. Although vehicle manufacturers must report the number of vehicles known or estimated to have the defect when the defect report is submitted to EPA, the defect reporting program nowhere obligates the vehicle manufacturer to report how many vehicles ultimately experience the defect. For this reason, the pervasiveness of defects is likely known only by each vehicle manufacturer.

IV. Analysis of Technical Data

The survey of automaker defect reports described above provides a substantial body of information that can be used to determine how defects are typically detected (and the corollary set of criteria governing whether emission-related components perform satisfactorily in-use), the frequency and scope of emission-related component defects, and the remedial measures taken by automakers in response to the occurrence of a defect. In the sections that follow, each of these issues is separately addressed.

A. The Criteria for Identifying Emission-Related Component Defects

The review of defect reports received from EPA confirms that automakers typically identify emission-related component defects in one of two ways—namely, consumer complaints regarding vehicle performance, or OBD MIL illumination. As previously noted, between the two methods, OBD MIL illumination is by far the most common means of identifying failed or defective emission-related components. Reliance upon the vehicle's OBD system to identify defects in emission-related components is an expected result because it is fully consistent with the regulatory programs EPA has independently established to monitor the in-use performance of motor vehicles. As explained more fully below, the relevant EPA regulatory programs either rely upon: (1) the operation of the vehicle's OBD system directly; or (2) criteria that are functionally similar to those mandated for design of acceptable vehicle OBD systems. These EPA criteria for assessing in-use vehicle performance provide a readily available and practically sanctioned means to implement the defect reporting program.

1. OBD Certification Performance Criteria

As already noted, EPA's vehicle certification program mandates that automakers design vehicles equipped with OBD systems that can detect the failure or degradation of specified emission-related components subject to specified criteria. Although the specified criteria are linked to the certification emission standards to which the vehicle as a whole must be designed, the link is not a direct one. Typically, the OBD MIL must illuminate before a degraded or failed emission-related component results in vehicle emissions that are 1.5 times the applicable in-use vehicle standard.

Despite the disparity between certification emission standards and the OBD MIL illumination standards, EPA has recently proposed reliance upon the vehicle's OBD system for the purpose of assessing component durability as part of the vehicle certification process under the Clean Air Act (CAA).[42] In particular, EPA has proposed that vehicle manufacturers operate one or more vehicles representing the full range of vehicles they produce for the full useful life of the vehicle using a driving cycle created by EPA for that purpose. As explained by EPA, "[t]he vehicle's OBD system is designed to monitor most emission control components and report faults by illuminating [the] malfunction indicator light. EPA is proposing that the OBD light will be used to detect emission control component failures during mileage accumulation."[43]

EPA expressed confidence that reliance on a single test vehicle would be sufficient because "most of the emission control technologies and components used by manufacturers are very similar in design and function among their different vehicle models."[44]

EPA's proposal to rely on the vehicle's OBD light to detect emission component failure for the purpose of vehicle certification is precisely what automakers have done for the purpose of identifying defects that must be reported to EPA.

41. Honda Defect Report, EPA Reference Number 2474.

42. EPA's certification program is mandated by §206 of the CAA. *See generally* 42 U.S.C. §7545, ELR Stat. CAA §206.

43. 71 Fed. Reg. at 2847.

44. *Id.* at 2848.

As such, it validates automaker reliance upon vehicle OBD systems for implementing their defect reporting obligations.

2. In-Use Verification Vehicle Testing Criteria

EPA's certification program also requires all vehicle manufacturers to meet a uniform set of in-use verification testing requirements for the vehicles they certify.[45] The criteria established by the in-use verification provisions (IUVP) are functionally similar to the OBD criteria noted above. The IUVP program requires manufacturers to test a small number of low-mileage (10,000-mile minimum) and high-mileage (50,000-mile minimum) vehicles that have been operated in consumer use and to report the results to EPA. The minimum number of vehicles that must be tested increase with increasing vehicle sales, ranging from two to not more than six vehicles. Vehicles must be procured randomly based on solicitations to owners of the targeted vehicle in a specific mailing area and candidate test vehicles can be rejected based on rejection criteria established by EPA.[46] If the IUVP data for a test group using the certification program's FTP and the "US06" portion of the SFTP exceeds certain triggering criteria, manufacturers must conduct additional "confirmatory" in-use testing. The triggering criteria for the additional testing are mean tailpipe emissions for the test group as a whole of any pollutant(s) which are 1.3 times the applicable in-use standard, coupled with a failure rate for the corresponding pollutant(s) of 50% or greater for the test group at either the low- or high-mileage test points.[47]

EPA requires the additional confirmatory testing for two reasons. The first relates to the potential exercise of EPA's authority under §207 of the CAA to order the recall of vehicles that do not conform to applicable emission and performance standards when in use.[48] The second relates to the test procedures used by automakers to demonstrate that the vehicles they produce will meet certification emission standards. Automakers must reassess the adequacy of their certification test procedures for any vehicle groups that exceed the criteria triggering the requirement for additional confirmatory testing, and revise the test procedures accordingly when the test procedures are determined to be inadequate to predict in-use performance.[49] (Surprisingly, the specific test procedures used by vehicle manufacturers for vehicle certification are considered proprietary by automakers despite the fact that EPA relies on the test procedures to make its certification decisions. The secrecy of the vehicle certification process prompted litigation that forced EPA to make the certification program more transparent to the public.)[50]

The 1.3 times the applicable in-use standard is conceptually similar to the 1.5 times the certification standard for OBD system operation, except that the IUVP criterion is a mean value for the set of vehicles subject to IUVP testing. Reliance on a mean value allows for the occurrence of vehicles that have emissions in excess of the 1.5 times the standard OBD criterion so long as there are sufficient counterbalancing vehicles to bring the resulting overall mean below 1.3 times the applicable standard. In either case, the criteria signaling acceptable performance, whether to assess the vehicle's individual emission-related components or the vehicle as a whole, have been established at levels well in excess of the vehicle's certification emission standards.

3. Inspection/Maintenance Vehicle Testing Criteria

Inspection/maintenance (I/M) programs apply in certain regions of Canada and the United States with elevated air pollution levels. The central objective of these I/M programs is to monitor and reduce emissions from the fleet of in-use vehicles by identifying vehicles with emission control system defects and ensuring that any such defects are properly repaired. Although I/M programs typically relied in the past upon tailpipe testing to assess vehicle performance, I/M programs now rely upon the vehicle's OBD system to evaluate the emission control performance of newer vehicles. Vehicles with operational OBD systems and no stored DTCs or OBD MIL illumination are deemed to pass the test. By contrast, vehicles with the OBD MIL illuminated or having stored DTCs fail the I/M test and must be repaired to correct the defect identified by the OBD system.[51]

In short, the multifaceted regulatory program established by EPA for assessing in-use vehicle performance is fully consistent with automaker reliance on OBD system monitoring for the purpose of identifying failed or degraded emission-related components. All of EPA's regulatory programs either rely directly upon the operation of the vehicle's OBD system or criteria that are functionally similar to those mandated for design of acceptable vehicle OBD systems.

B. The Frequency and Scope of Emission-Related Component Defects

This Article confirms that the occurrence of emission-related defects is a common experience shared by all of the surveyed automakers. Although the degree to which each surveyed automaker submitted defect reports varied from one automaker to the next (with some automakers submitting more reports and some less), all of the targeted automakers have reported the occurrence of dozens of defects. These defects extended to every model year in the surveyed population, i.e., the 2001 through 2006 model years, and dozens of makes in each model year across the range of vehicle manufacturers. Collectively, million of vehicles are potentially impacted by the defects which are the subject of this survey.

Although it is not possible to ascertain the frequency of defects in the 2001 to 2006 vehicle population for the relevant automakers with a high degree of precision, the results of the survey appear to confirm EPA's expectations regarding the importance of vehicle calibration to achieving Tier 2 standards. The 2001 model year coincides with broader application of EPA's National Low-Emission Vehicle (LEV) program, which involved the early introduction of Tier 2 emission standards in the United States. When EPA adopted the Tier 2 emission standards in 1999, EPA determined that

45. *See* 40 C.F.R. §86.1845-01.

46. *See* 40 C.F.R. pt. 86, subpt. S, app. I.

47. *Id.* §86.1846-01(b).

48. 64 Fed. Reg. 23906, 23909 (May 4, 1999) ("the IUVP data . . . may be used by the Agency in determining whether an emission recall is necessary").

49. 71 Fed. Reg. at 2814.

50. *See generally* Ethyl Corp. v. EPA, 306 F.3d 1144, 33 ELR 20075 (D.C. Cir. 2002). In response to the litigation, EPA changed some of its certification regulations and has proposed to change others. 71 Fed. Reg. at 2810-43; *id.* 2843 (Jan. 17, 2006).

51. 40 C.F.R. §85.2207.

"the standards being promulgated today for gasoline-fueled vehicles are well within the reach of existing control technology."[52] EPA explained that its determination of feasibility "is based on the use of catalyst-based strategies that are already in use and well proven in the existing fleet of vehicles" and that "[t]here is no need to invent new approaches or technologies."[53] Instead, what EPA determined would be required is "optimization of these existing technologies."[54]

EPA identified four basic improvements in vehicle design and operation that would enable compliance with the Tier 2 emission standards.

> The most significant improvements which have facilitated these low emission levels have been to traditional *catalysts*, which now warm up very rapidly and are substantially more durable than past technology, and to *fuel metering*, which is more precise and accurate than previous systems. Improvements have also been made to *base engine designs*, which have resulted in lower engine-out emissions…Perhaps most important of all, *emission control calibrations* continue to become more refined and sophisticated.[55]

Expanding on the last of the anticipated improvements, EPA noted that "one of the most important emission control strateg[ies] is not hardware-related," but rather "software-related" because it "involves the algorithms and calibrations contained within the software that are used in the power-train control module (PCM) which control how the various engine and emission control components and systems operate."[56] As explained by EPA:

> Advancements in software along with refinements to existing algorithms and calibrations can have a major impact in reducing emissions. Confidential discussions between manufacturers and EPA have suggested that manufacturers believe emissions can be further reduced by improving and updating their calibration techniques. As computer technology and software continues to advance, so does the ability of the automotive engineer to use these advancements in ways to better optimize the emission control systems. For example, as processors become faster, it is possible to perform calculations more quickly, thus allowing for faster response times for controlling engine parameters, such as fuel rate and spark timing. As the PCM becomes more powerful with greater memory capability, algorithms can become more sophisticated . . . resulting in even lower emissions.[57]

In general terms, the review of the defect reports received from EPA confirms EPA's expectations regarding the importance of vehicle calibration to achieving Tier 2 standards. As noted above, nearly 40% of the defect reports pertained to some form of software defect either in the vehicle's calibration or OBD operating system. That such a large percentage of reports pertain to software issues highlights how important software design is to the overall performance of vehicles equipped with advanced emission control technology while in consumer use. Similarly, the fact that far fewer defects have been reported for the main hardware components of advanced vehicle emission control systems, i.e., catalytic converters, oxygen sensors, and spark plugs, is fully consistent with EPA's collateral expectation that the "catalyst-based strategies" that would be used by automakers in Tier 2 vehicles "are already in use and well proven."[58]

What is not clear is whether EPA anticipated that defects in vehicle calibration or OBD system operation could negatively impact vehicle hardware performance. As this Article clearly establishes, defects in vehicle or OBD system calibration can and do result in the failure of the "well proven" hardware to which EPA referred when it adopted the Tier 2 emission standards.[59]

C. Action to Remedy Defective Emission-Related Components

Section 207 of the CAA authorizes EPA to recall vehicles that do not perform adequately when in consumer use. In particular, §207(c)(1) provides that

> [i]f the Administrator determines that a substantial number of vehicles or engines, although properly maintained and used, do not conform to the regulations prescribed under [§202 of the Act] when in actual use throughout their useful life . . . he shall immediately notify the manufacturer thereof of such nonconformity, and shall require the manufacturer to submit a plan for remedying the nonconformity . . . .[60]

EPA's defect reporting program provides one body of information EPA can use to determine if the performance of vehicles when in-use conforms to applicable regulatory requirements for the purpose of implementing §207(c)(1).

Highlighting the importance of the defect reporting program to the maintenance of air quality, EPA has recently conducted enforcement actions against DaimlerChrysler and Volkswagen for alleged failures to submit defect reports in a timely manner. In the complaint against Volkswagen, the United States alleged that Volkswagen delayed reporting for more than one year a defect in oxygen sensor performance that potentially impacted hundreds of thousands of vehicles in the field.[61] According to the U.S. allegations, Volkswagen knew that 25 or more vehicles had the defect no later than May 2000, but Volkswagen delayed reporting the defect until June 2001. As part of a settlement of the enforcement action, Volkswagen agreed to pay a civil penalty of $1.1 million and to enhance its system for monitoring, investigating and reporting defects to EPA.[62] Urging the court to adopt the proposed consent decree, the government made the following statement:

> While VWoA cooperated fully with EPA in completing a voluntary recall, and in reimbursing consumers who may have paid for prior repairs of failed O2 sensors at a cost of nearly $ 26 million, VWoA did not timely file an EDIR with EPA. *The government considers this to be a serious violation of Title II of the Act because of the importance of timely and accurate self-reporting by manufacturers, and a substantial penalty is neces-*

52. 65 Fed. Reg. 6697, 6724 (Feb. 10, 2000).
53. *Id.*
54. *See id.* at 6724-25.
55. U.S. EPA, Tier 2/Sulfur Regulatory Impact Analysis IV-1 (1999) (emphasis added).
56. *Id.* at IV-14.
57. *Id.*
58. *See* 65 Fed. Reg. at 6697, 6724.
59. *See generally* Part III.C.
60. 42 U.S.C. §7541(c)(1).
61. United States of America v. Volkswagen of America, Inc., Civil Action No. 1:05-CV-001193-GK, ¶¶ 13-26 (D.D.C. June 15, 2005).
62. 70 Fed. Reg. 40734 (July 14, 2005).

> *sary to deter future noncompliance.* A $1.1 million civil penalty makes clear that EPA will vigorously enforce a manufacturer's obligation to timely report emission-related defects.[63]

The enforcement action against DaimlerChrysler involved similar allegations of dilatory reporting, but extended to a substantially broader array of emission component defects. The United States alleged that DaimlerChrysler discovered defects in certain catalytic converters, mass air flow sensors, fuel filter caps, air injection pumps, fuel tank pressure sensors, spark plug cables, and ignition modules, but failed to report the defects in a timely manner.[64] Collectively, the government alleged that DaimlerChrysler had delayed the reporting of more than two million potential defective components. A proposed consent decree submitted to the court to resolve the enforcement action would require DaimlerChrysler to pay a $1.2 million civil penalty and, like Volkswagen, to enhance its system of monitoring, investigating, and reporting defects to EPA.[65]

As noted above, EPA initiated its enforcement actions against DaimlerChrysler and Volkswagen because of the importance of timely and accurate self-reporting by manufacturers. The noted enforcement actions may also have been prompted, in part, by the self-policing nature of the defect reporting program. This Article shows that EPA generally defers to automaker judgments that the occurrence of defects in-use will result in illumination of the OBD system's MIL light and a decision, in turn, by the vehicle's operator to seek appropriate repairs or maintenance. Confirming this commonplace outcome for remedying defects, the VERR Review Checklist completed by EPA staff following review of a new defect report contains a box that is expressly labeled, "self-campaigning." This self-campaigning box is typically checked on the checklist form. Because the defect reporting program is both self-reporting and self-policing, EPA may view timely reporting to be especially critical to the exercise of EPA's parallel authority to mandate recall of vehicles for repair, when appropriate.[66]

Finally, the self-policing approach to the repair or replacement of defective emission-related components necessarily means that defects do not typically encompass degraded components that merely increase vehicle emissions, even where the increase may be substantial. Only emission degradation sufficient to trigger illumination of the vehicle's OBD MIL qualifies as a defect in need of repair or replacement. This is so even if emissions increase to a level that exceeds the emission standards to which the vehicle was certified, provided the threshold for triggering OBD system MIL illumination have not been exceeded.

63. Memorandum of Points and Authorities in Support of Motion to Enter Consent Decree, at 13 (Nov. 4, 2005), *in Volkswagen*, No. 1:05-CV-001193-GK [hereinafter VW Memorandum].

64. United States v. DaimlerChrysler AG et al., Civil Action No. 1:06CV02172, ¶¶ 13-60 (D.D.C. Dec. 21, 2006). Despite the fact that DaimlerChrysler submitted defect reports for catalytic converters in some 2001 and later model-year vehicles, EPA's response to FOIA requests for DaimlerChrysler defect reports did not include any such reports. This suggests that the list of defective converters in Table 11 is incomplete.

65. 72 Fed. Reg. 799 (Jan. 8, 2007).

66. *See* VW Memorandum, *supra* note 64, at 18 ("The defect reporting requirements are intended to give EPA information necessary to implement its recall authority . . . .").

V. Conclusion

The foregoing survey of defect reports submitted to EPA by vehicle manufacturers supports a wide range of conclusions.

- The occurrence of emission-related defects is a common experience shared by all surveyed automakers. Collectively, millions of 2001 through 2006 model-year vehicles are potentially impacted by the defects which are the subject of this survey.
- The most common means used by the surveyed automakers to identify failed or defective emission-related components is illumination of the vehicle's OBD MIL. All surveyed automakers rely on the vehicle's OBD system for this purpose. In some cases, however, OBD MIL illumination is not sufficient by itself to establish a defective emission-related component because the OBD system may have been calibrated to be too sensitive, i.e., it identifies a failed component that retains adequate performance.
- The surveyed automakers generally treat changes in emissions caused by component deterioration—even if substantial—as unimportant unless the changes cause the vehicle to fail one or more applicable in-use performance criteria, typically the OBD MIL illumination threshold for the particular component at issue. EPA has sanctioned this approach.
- The surveyed automakers generally rely on very limited testing—or no testing at all—to determine the degraded component's impact on vehicle emissions. When testing is conducted, vehicle manufacturers often test the failed component in isolation, ignoring that the failed component might have impacted the performance of other emission-related components.
- The surveyed automakers typically do not recall vehicles for the repair of defective emission-related components. While recalls do occur from time to time, the far more prevalent response is to rely on the vehicle's OBD system to alert the vehicle's owner when repairs are needed. EPA has sanctioned this self-policing approach to vehicle repair.
- The single most frequently reported defect (approximately 40% of the total reported defects) is one pertaining to software coding for either the vehicle's calibration or the OBD system. By contrast, defects in major emission system components, such as the catalytic converter, oxygen sensors, or spark plugs, occur far less frequently, albeit still making up approximately 5% of the total in each instance. Even in the case of defective catalytic converters, oxygen sensors, and spark plugs, moreover, recalibration of the vehicle's on-board computer is the most frequently cited remedy.
- Except in the case of recalls or special service campaigns, which occur relatively infrequently, defect reports typically provide no basis to assess how extensively a defect may be encountered by vehicles in consumer use because warranty or other similar data pertaining to individual defects is not uniformly provided by automakers. (Whether EPA

or other regulatory bodies seek out information of this sort in other ways is beyond the scope of this Article.) When such data is provided, the data generally show an increasing number of repairs as the vehicles in the affected groups age, i.e., as they accumulate mileage in consumer use.

- Automaker reliance on vehicle OBD systems to identify failed or degraded emission-related components is fully consistent with the regulatory programs EPA has developed to monitor the in-use performance of motor vehicles. All of the relevant EPA programs rely either upon: (1) the operation of the vehicle's OBD system directly; or (2) criteria that are functionally similar to those mandated for design of acceptable OBD systems.

Whether similar conclusions apply for defect reports submitted to Canadian regulators is not yet known. A parallel survey of Canadian defect reports is planned and will be reported separately.

Appendix 1

Appendix VIII to Part 85—Vehicle and Engine Parameters and Specifications

A. Light-Duty Vehicle Parameters and Specifications

I. Basic Engine Parameters—Reciprocating Engines.
   1. Compression ratio.
   2. Cranking compression pressure.
   3. Valves (intake and exhaust).
      a. Head diameter dimension.
      b. Valve lifter or actuator type and valve lash dimension.
   4. Camshaft timing.
      a. Valve opening (degrees BTDC).
      b. Valve closing (degrees ATDC).
      c. Valve overlap (inch-degrees).
II. Basic Engine Parameters—Rotary Engines.
   1. Intake port(s).
      a. Timing and overlap if exposed to the combustion chamber.
   2. Exhaust port(s).
      a. Timing and overlap if exposed to the combustion chamber.
   3. Cranking compression pressure.
   4. Compression ratio.
III. Air Inlet System.
   1. Temperature control system calibration.
IV. Fuel System.
   1. General.
      a. Engine idle speed.
      b. Engine idle mixture.
   2. Carburetion.
      a. Air-fuel flow calibration.
      b. Transient enrichment system calibration.
      c. Starting enrichment system calibration.
      d. Altitude compensation system calibration.
      e. Hot idle compensation system calibration.
   3. Fuel injection.
      a. Control parameters and calibration.
      b. Fuel shutoff system calibration.
      c. Starting enrichment system calibration.
      d. Transient enrichment system calibration.
      e. Air-fuel flow calibration.
      f. Altitude compensation system calibration.
      g. Operating pressure(s).
      h. Injector timing calibrations.
V. Injection System.
   1. Control parameters and calibration.
   2. Initial timing setting.
   3. Dwell setting.
   4. Altitude compensation system calibration.
   5. Spark plug voltage.
VI. Engine Cooling System.
   1. Thermostat calibration.
VII. Exhaust Emission Control System.
   1. Air injection system.
      a. Control parameters and calibrations.
      b. Pump flow rate.
   2. EGR system.
      a. Control parameters and calibrations.
      b. EGR valve flow calibration.
   3. Catalytic converter system.
      a. Active surface area.
      b. Volume of catalyst.
      c. Conversion efficiency.
   4. Backpressure.
VIII. Evaporative Emission Control System.
   1. Control parameters and calibrations.
   2. Fuel tank.
      a. Pressure and vacuum relief settings.
IX. Crankcase Emission Control System.
   1. Control parameters and calibrations.
   2. Valve calibration.
X. Auxiliary Emission Control Devices (AECD).
   1. Control parameters and calibrations.
   2. Component calibration(s).
XI. Emission Control Related Warning Systems.
   1. Control parameters and calibrations.
   2. Component calibrations.
XII. Driveline Parameters.
   1. Axle ratio(s).

B. Heavy Duty Gasoline Engine Parameters and Specifications

I. Basic Engine Parameters.
   1. Compression ratio.
   2. Cranking compression pressure.
   3. Supercharger/turbocharger calibration.
   4. Valves (intake and exhaust).
      a. Head diameter dimension.
      b. Valve lifter or actuator type and valve lash dimension.
   5. Camshaft timing.
      a. Valve opening (degrees BTDC).
      b. Valve closing (degrees ATDC).
      c. Valve overlap (inch-degrees).
II. Air Inlet System.
   1. Temperature control system calibration.
III. Fuel System.
   1. General.
      a. Engine idle speed.
      b. Engine idle mixture.
   2. Carburetion.
      a. Air-fuel flow calibration.
      b. Transient enrichment system calibration.
      c. Starting enrichment system calibration.
      d. Altitude compensation system calibration.
      e. Hot idle compensation system calibration.
   3. Fuel injection.
      a. Control parameters and calibrations.
      b. Fuel shutoff system calibration.
      c. Starting enrichment system calibration.
      d. Transient enrichment system calibration.
      e. Air-fuel flow calibration.
      f. Altitude compensation system calibration.
      g. Operating pressure(s).
      h. Injector timing calibration.
IV. Ignition System.
   1. Control parameters and calibration.
   2. Initial timing setting.
   3. Dwell setting.
   4. Altitude compensation system calibration.
   5. Spark plug voltage.
V. Engine Cooling System.
   1. Thermostat calibration.
VI. Exhaust Emission Control System.
   1. Air injection system.
      a. Control parameters and calibrations.
      b. Pump flow rate.
   2. EGR system.
      a. Control parameters and calibrations.
      b. EGR valve flow calibration.
   3. Catalytic converter system.

a. Active surface area.
b. Volume of catalyst.
c. Conversion efficiency.
4. Backpressure.
VII. Evaporative Emission Control System.
1. Control parameters and calibrations.
2. Fuel tank.
a. Pressure and vacuum relief settings.
VIII. Crankcase Emission Control System.
1. Control parameters and calibrations.
2. Valve calibrations.
IX. Auxiliary Emission Control Devices (AECD).
1. Control parameters and calibrations.
2. Component calibrations.
X. Emission Control Related Warning Systems.
1. Control parameters and calibrations.
2. Component calibrations.

C. Heavy Duty Diesel Engine Parameters and Specifications

I. Basic Engine Parameters-Four Stroke Cycle Reciprocating Engines.
1. Compression ratio.
2. Cranking compression pressure.
3. Supercharger/turbocharger calibration.
4. Valves (intake and exhaust).
a. Head diameter dimension.
b. Valve lifter or actuator type and valve lash dimension.
5. Camshaft timing.
a. Valve opening (degrees BTDC).
b. Valve closing (degrees ATDC).
c. Valve overlap (inch-degrees).
II. Basic Engine Parameters Two-Stroke Cycle Reciprocating Engine.
1.-5. Same as Section C.I.
6. Intake port(s).
a. Timing in combustion cycle.
7. Exhaust port(s).
a. Timing in combustion cycle.
III. Air Inlet System.
1. Temperature control system calibration.
2. Maximum allowable air inlet restriction.
IV. Fuel System.
1. Fuel injection.
a. Control parameters and calibrations.
b. Transient enrichment system calibration.
c. Air-fuel flow calibration.
d. Altitude compensation system calibration.
e. Operating pressure(s).
f. Injector timing calibration.
V. Exhaust Emission Control System.
1. Maximum allowable backpressure.
VI. Crankcase Emission Control System.
1. Control parameters and calibrations.
2. Valve calibrations.
VII. Auxiliary Emission Control Devices (AECD).
1. Control parameters and calibrations.
2. Component calibration(s).

[42 FR 28129, June 2, 1977]

Appendix 2

DR Review Checklist (from §85.1903)

EPA Number: 2121 (Check that all information shown below has been submitted) **Mfr.:** Toyota
Mfr. Number: 20030724

1. Manufacturer's corporate name	☑
2. Description of defect	☑
3. Description of class of Category of vehicle or engine	☑
4. For each class: Number of affected vehicles, how this number was determined and plant address	☑
5. Emissions impact and description of driveability problems	☑
6. Related emissions data	☑
7. Indication of any anticipated manufacturer follow-up	☑

Review of DR:	Yes	No
1. Does this defect cause the vehicle to fail to meet the emissions standards in-use?	☐	☑
1a. Are emissions data available? (Please attach to this worksheet)	☐	☑
2. Mis-build? (Vehicles being produced do not represent any certified configuration in the test group) (If yes, contact Tom Ball and check mis-build under Violations below)	☐	☑
3. Is this defect self Campaigning?	☑	☐
3a. How did the manufacturer discover the problem? (Was a MIL code set?; Was the driver alerted some other way?)		
3b. (Does the defect cause a no-start condition, driveability problem or some other very obvious problem to the operator of the vehicle, not including MIL light illumination?) (Please elaborate below in comments)	☑	☐
4. Are there other vehicles in the engine family that could be affected?	☑	☐
4a. How many of these vehicles are in the field?		
4b. How did the manufacturer arrive at this number? (For both 4a. and 4b. please elaborate below in comments)		
5. What is the root cause of the defect? (For 5. please elaborate below in comments)		
5a. Has it been corrected? (If yes, what is the VIN of the first vehicle and date the fix was performed-from and to)	☐	☐
6. Are other engine families using the same part or technology? (Please elaborate below in comments)	☑	☐
7. Does the manufacturer have a fix for the defect?	☑	☐
7a. What corrective action is planned? (For 7a. please elaborate below in comments)		

1a. Comments:	
3a. Comments:	
3b. Comments:	
4a. Comments:	14.000
4b. Comments:	
5a. Comments:	Throttle Body Mtr. malfunction
6a. Comments:	
7a. Comments:	

CCD Evaluation and Violations:
Emissions impact: major ☐; minor ☐; none ☑
Safety impact: major ☐; minor ☐; none ☑
VERR submitted to EPA ☑
Mfr. Performed service campaign but did not submit VERR ☐
Potential OBD violation ☐ (Notify Arvon)
Approx. failure rate ____% (No. of defects / No. of veh's affected)
Failure rate likely to increase over useful life of veh's ☐ (yes, request DR update, see Potential failure) ☐
Possibility of induced tampering due to driveability problems ☐
Potential OECA Violation: None☐;
Failure to Certify ☐; Mis-build ☐; Underhood Label Violations☐;
Delayed submittal ☐; Illegal Importation ☐; Defeat Strategies ☐
TBD: Need more info. ☐ (check follow-up action below)
Resolution / Follow-up action:
Reviewed, no further action ☑; Request VERR from Mfr ☐;
Referred to steering committee ☐; (date: ___/___/___)
Other ☐(make statement); Request add'l info. from Mfr. ☐

Notified NHTSA ☐; (date: ___/___/___)
Notified Arvon (OBD violation) (date: ___/___/___)
Letter or other means requesting more info from Mfr☐;
Mfr. agrees to voluntary emission recall ☐;
Potential failure: Requested additional DR updates ☐
(DR updates are requested quarterly for 1 year and must contain updated failure rates)

Mfr. Rep.: [signature]
EPA Reviewer: B.L.
Date: 09/23/03 Time: 15:18 AM/PM
DR / VERR Group Leader: [signature]
Added to data base: 10/20/2003

Revised 8/21/02 000278

Appendix 3
Table 11: Defect Reports Relating to Catalytic Converter Operation

Manufacturer and EPA Reference #	Model Year and Model	# of Affected Vehicles	Defect Description	Remedy
Ford/#2134	2001 Mustang 2002 Mustang 2003 Mustang 2004 Mustang	Unknown	3.8L Mustang passenger cars may have cracked catalytic converter inlet pipes due to modal bending at a specific resonant frequency and air conditioning condensate draining on the inlet pipe to converter weld joint.	New exhaust support brace
Ford/#2496	2003 & 2004 CrownVic 2003 & 2004 Grand Marquis 2003 & 2004 Town Car	Unknown	Due to an FCSD cataloging error, dealers may have installed an incorrect service right hand catalytic converter in some of the affected vehicles.	Replace catalytic converter
Ford/#2527	2004 & 2005 CrownVic 2004 & 2005 Grand Marquis 2004 & 2005 Town Car	293,100	Some 2004 and 2005 4.6L Crown Victoria (Police)/ Crown Victoria/Grand Marquis/Town Car passenger cars may have Catalytic Converter substrates that move and rattle against the interior of the Catalytic Converter can outlet cone.	Unknown
Ford/#2591	2005 Escape 2005 Mariner	57,600	Some 2005 model 3.0L Escape/Mariner trucks have a spark plug fouling software strategy that does not sufficiently determine the usage of assembly plant fuels during assembly plant vehicle maneuvering. This condition may cause spark plug fouling resulting in clogged catalytic converters and is present only for a short period after production.	Recalibration
Ford/#2605	2005 Tribute	16,800	Some 2005 model 3.0L Escape/Mariner trucks have a spark plug fouling software strategy that does not sufficiently determine the usage of assembly plant fuels during assembly plant vehicle maneuvering. This condition may cause spark plug fouling resulting in clogged catalytic converters and is only present for a short period after production.	Unspecified repair procedure
Ford/#2636	2006 Lincoln Mark LT	9,200	Some 2006 model 5.4 L Lincoln Mark LT trucks may have [been] built with incorrect catalytic converters.	Unknown
Honda/#2072	2001 Odyssey 2003 Accord	305,482	The OBD system may falsely detect catalyst deterioration and illuminate the MIL although catalyst performance is sufficient to meet the applicable OBD emission threshold. This is because the Oxygen Storage Capacity level of in-use vehicles is relatively lower than that expected during development.	Improved catalytic converter
Honda/# 2092	2002 Civic 2003 Civic 2004 Civic IMA	17,455	The OBD system may falsely detect NO_x Adsorptive Catalyst deterioration and illuminate the MIL although catalyst performance is sufficient to meet the applicable emission standard.	Recalibration
Honda/#2399	2002 RSX 2003 RSX 2004 RSX	80,256	The gasket between the catalyst and exhaust manifold may be worn on some vehicles. This could result in exhaust gas leak.	Improved gasket
Honda/#2473	2001 Civic 2002 Civic 2003 Civic 2004 Civic	675,157	The exhaust manifold with close-coupled catalyst may crack due to repeated exposure to excessive thermal stress.	Unspecified repair under warranty
Honda/#2477	2003 Civic IMA 2004 Civic IMA 2005 Civic IMA	71,394	Under specific limited driving conditions, inappropriate Air-to-Fuel ratio causes catalyst heat damage. The catalyst oxygen storage capacity is reduced, and the MIL illuminates.	Recalibration
Toyota/#1635	2001 RAV4 2002 RAV4	151,600	MIL illumination related to the catalytic converter (P0420/P0430) due to improper OBD logic and early deterioration of oxygen storage capacity of the catalytic converter.	Improved catalytic converter and recalibration

Table 11: Defect Reports Relating to Catalytic Converter Operation (cont.)

Manufacturer and EPA Reference #	Model Year and Model	# of Affected Vehicles	Defect Description	Remedy
Toyota/#2087	2004 RX330	12,500	Due to improper installation of the mat during converter assembly, the catalytic converter substrate can slide and contact the sides of the steel converter shell resulting in an objectionable buzzing noise.	Replace converter
Toyota/#2088	2001 Highlander	11,500	MIL illumination related to catalytic converter (P0420/P0430) due to improper OBD logic.	Recalibration
Toyota/#2219	2001 Prius	13,000	Under certain conditions a misfire may occur when fuel pressure decreases due to fuel shortage or fuel pump or fuel pressure regulator component malfunction. Due to limited OBD monitoring logic, the OBD cannot detect such a misfire and the catalytic converter is damaged. Consequently, the MIL is illuminated and the code for the catalytic converter (P0420) is set.	Recalibration and converter replacement
Toyota/#2264	2002 Camry 2002 Solara 2003 Camry 2003 Solara 2004 Camry 2004 Solara	785,586	MIL illumination related to the catalyst performance (P0420) due to misfire under light engine load conditions.	Recalibration
Toyota/#2516	2001 Celica 2002 Celica 2003 Celica 2004 Celica 2005 Celica	72,000	During decelerations under light load conditions, high temperature deterioration of the catalyst may occur. Vehicles that experience a degradation in catalyst performance from this unique drive condition will be identified by the OBD system with MIL illumination and DTC (P0420).	Catalyst replacement
Toyota/#2517	2002 Highlander	19,500	MIL illumination related to catalytic converter (P0420/P0430).	Unknown
Volkswagen/#2063	2002 A4 2002 A6	26,334	MIL On (P0421/P0431 – Catalyst Efficiency Below Threshold) conditions were generally caused by minor leaks in the exhaust system prior to the catalytic converter. This condition causes outside air to be mixed with burnt exhaust gas and gives incorrect readings to the oxygen sensor of the given exhaust efficiency.	Improved welding
Volkswagen/#2319	2001 Golf 2001 Jetta 2001 Beetle	40,755	Converter monoliths are broken, cracked or eroded.	Improved catalytic converter
Volkswagen/#2490	2001 Jetta 2001 GTI	37,319	Melted converter monolith with DTC P0420 (catalytic converter efficiency below threshold), DTC P0300 (miscellaneous misfire faults), DTC P0301 to P0306 (misfire cylinder 1 to 6) and rattling noise under vehicle.	Unknown
Volkswagen/#2500	2001 & 2002 Beetle Golf GTI Jetta Audi TT	132,034	MIL illuminated for catalytic converter and rattling noise under vehicle.	Unknown
Volkswagen/#2586	2001-2003 Golf Jetta Beetle	307,758	DTC Code P0422: Main Catalyst Bank 1 (efficiency below threshold).	Unknown
Total		**3,136,330**		

Appendix 3
Table 12: Defect Reports Relating to Oxygen Sensor Operation

Manufacturer and EPA Reference #	Model Year and Model	# of Affected Vehicles	Defect Description	Remedy
DaimlerChrysler/ #2509	2005 Sebring 2005 Stratus	33,784	Some 2005 MY vehicles may have a rear oxygen sensor wiring harness routed close enough to the rear transmission bracket that chafing may occur and result in a short to ground. If this should happen, the OBD oxygen sensor heater diagnostic will detect the condition and illuminate the Malfunction Indicator Lamp (MIL).	None – Self policing
DaimlerChrysler/ #2555	2005 Ram	111,638	Some 2005 model year vehicles may experience a Malfunction Indicator Lamp (MIL) illumination due to the downstream Oxygen (O_2) sensor having a cracked thimble. Cracks can develop in the thimble of the downstream sensor if water in the exhaust system contacts and thermally shocks it during engine warm-up.	Recalibration and O_2 sensor replacement
DaimlerChrysler/ #2575	2005 & 2006 Magnum 300 300C 2006 Charger	289,419	Some 2005 and 2006 model year vehicles may experience corrosion in the Oxygen (O_2) sensor connectors due to water draining from the cowl. If this condition occurs it will be detected by the OBD system and the Malfunction Indicator Lamp (MIL) will be illuminated. The upstream oxygen sensors are directly in the path of the water and have the highest incidence of claims.	Reposition sensors and replace O_2 sensor as needed
DaimlerChrysler/ #2663	2006 Jeep® Liberty	14,482	The wiring for the left rear O_2 sensor on some 2006 MY Jeep® Liberty vehicles may contact the exhaust and melt, resulting in possible electrical shorts. If this should happen, the OBD oxygen sensor diagnostics will detect the condition and illuminate the Malfunction Indicator Lamp (MIL).	Redesigned O_2 wire length
Ford/#1920	2001 MPV	83,000	Some oxygen sensors may be painted near the atmospheric vent hole during fixing the oxygen sensor on the engine for checking tightening torque. The volatized gas from its paint entered through the vent hole into oxygen sensor. It causes Malfunction Indicator Lamp (MIL) illumination.	Unknown
Ford/#2017	2001 MPV	87,000	Some 2000-2001 MY Mazda PPV and 1999-2000 MY Mazda Mx-5 may have inoperative Heated Exhaust Oxygen Sensors due to breaking of the heater wire caused by corrosion. It causes Malfunction Indicator Lamp (MIL) illumination.	Unknown
Ford/#2122	2001 S40 2001 V40	35,254	If the front oxygen sensor signal is missing or faulty, the engine control module will adopt substitute values. The MIL will illuminate if this condition is sensed. The source of the problem is identified in the "Characteristic Sift Down," caused by poisoning the reference air inside the oxygen sensor. In this specific case, the heated oxygen sensor will self heal and work correctly again after one or two drive cycles.	New adapter cable to block PCV oil seepage
Ford/#2127	2001 Escorts	4,068	Some 2001 model 2.0L Escort passenger cars may have inoperative heated exhaust gas oxygen (HEGO) sensors due to oil being absorbed through the wire harness and contaminating the reference chamber.	Unknown
Ford/#2385	2002 Taurus 2002 Sable	136,800	Vehicles may have inoperative heated exhaust gas oxygen sensors due to mechanical shock. MIL is illuminated.	Unknown

Table 12: Defect Reports Relating to Oxygen Sensor Operation (cont.)

Manufacturer and EPA Reference #	Model Year and Model	# of Affected Vehicles	Defect Description	Remedy
Ford/#2472	2004 RX-8 2005 RX-8	52,000	If an RX-8 is parked and the engine is operated at high RPMs for an excessive length of time, some of the parts around the exhaust system can melt and produce a variety of malfunctions. The problems caused by the excessive heat build up can range from inoperative oxygen sensor . . . and in the worst case, possible fuel leaks resulting from heat damage to the fuel tank.	Recalibration and heat insulator
General Motors/ 2039	2002 Seville Deville Eldorado Aurora	16,080	The On-Board Diagnostic system may not be able to detect an oxygen sensor response malfunction until Nitrous Oxide (NO_x) emissions have exceeded the Federal Test Procedure (FTP) NO_x emission standards . . . DTCs P0133 and P0153 (Oxygen Sensor Circuit – Slow Response) are affected.	Recalibration
Honda/#1912	2001-2002 Accord	353,537	The system may falsely detect the deterioration of the primary oxygen sensor under certain driving conditions such as when EGR flow is high. Sensors may output an unexpected signal under such conditions. The MIL illuminates.	Recalibration, new fuel injectors, and improved O_2 sensor
Honda/#2596	2003 Accord	236,091	Some secondary oxygen sensors heater leads may experience corrosion, which may cause open-circuit. The MIL illuminates.	Improved O_2 sensor
Toyota/#2020	2002/2003 Tacoma	72,000	Condensed water in the exhaust system contacts the hot element of the O_2 sensor and causes the element to crack due to sudden temperature drop. The MIL is illuminated with code (P0136) being set.	Recalibration
Toyota/#2189	2001/2002 Tundra	152,615	Due to corrosion in high humidity areas, electrical discontinuity may occur on the heater circuit in the oxygen sensor. This causes the MIL to activate and OBD-II codes P0135/P0155 are set.	Improved O_2 sensor
Toyota/#2412	2001 LandCruiser LX470	17,839	Due to corrosion in high humidity areas, electrical discontinuity may occur on the heater circuit in the oxygen sensor. This causes the MIL to activate and OBD-II codes P0135/P0155 are set.	Improved O_2 sensor
Toyota/#2607	2002 LandCruiser LX470	14,929	Due to corrosion in high humidity areas, electrical discontinuity may occur on the heater circuit in the oxygen sensor. This causes the MIL to activate and OBD-II codes P0135/P0155 are set.	Improved O_2 sensor
Toyota/#2682	2002/2003 LS430 GS430 SC430	89,526	Due to corrosion in high humidity areas, electrical discontinuity may occur on the heater circuit in the oxygen sensor. This causes the MIL to activate and OBD-II codes P0135/P0155 are set.	Improved O_2 sensor
Volkswagen/ 1693 &1805	2001 Jetta 2001 Golf 2001 Beetle	26,035	The pre-oxygen sensor is mounted in the exhaust manifold, and under certain cold and damp ambient conditions, thermal shock can take place, cracking the internal ceramic element of the oxygen sensor.	Recalibration
Volkswagen/ #1873	2001 Jetta GTI (VR6)	37,583	The inner sensor element (which contains the sensor's oxygen reference) becomes contaminated and the sensor signal slowly decreases or deteriorates.	Part is ok (contamination is temporary)

Table 12: Defect Reports Relating to Oxygen Sensor Operation (cont.)

Manufacturer and EPA Reference #	**Model Year and Model**	**# of Affected Vehicles**	**Defect Description**	**Remedy**
Volkswagen/ #2130	2003 A6	9,897	Thermal shock within the sensor caused by moisture accumulation could cause oxygen sensor failure. If the oxygen sensor fails, the vehicle's "check engine" light on the dashboard will illuminate.	Recalibration and O_2 sensor replacement
Volkswagen/ #2277	2001 A6 2001 A8	4,511	In some cases, a malfunction was caused by a contamination inside the air reference chamber. This may happen along with moisture inside the sensor body due to reduced exhaust temperature in particular part load conditions with the 4.2L engine.	Improved production process
Total		**1,878,088**		

Appendix 3
Table 13: Defect Reports Relating to Spark Plug Operation

Manufacturer and EPA Reference #	Model Year and Model	# of Affected Vehicles	Defect Description	Remedy
DaimlerChrysler/ #2359	2004 Caravan 2004 Town & Country 2004 Jeep® Liberty 2004 Stratus 2004 Sebring 2004 Neon 2004 PT Cruiser 2005 Caravan 2005 Town & Country 2005 PT Cruiser	486,629	On certain vehicles, the dialectic strength of one or more spark plugs may be affected when a cylinder is ignited before it is fueled. If this happens (typically early in the life of the vehicle), subsequent operation at conditions demanding higher secondary voltages may result in engine misfire.	Recalibration and improved spark plugs
DaimlerChrysler/ #2507	2004 Durango 2005 Durango	89,534	Certain 2004 and 2005 MY vehicles may experience temporary engine misfire if sufficient water collects in the spark plug well and introduces a leak path to the ignition energy.	Installation of seals
DaimlerChrysler/ #2576	2005 300/ Magnum 2006 300/ Magnum 2006 Charger	Unknown	Some 2005 and 2006 model year vehicles with 3.5L engines may experience carbon buildup on the cylinder heads and valves. In some cases, this buildup may prevent the valves from seating properly and may result in engine misfires, which will ultimately lead to Malfunction Indicator Lamp (MIL) illumination.	Unknown
DaimlerChrysler/ #2598	2003 PT Cruiser	20,519	Some 2003 model year vehicles may exhibit an occasional, single misfire at engine speeds above 5200 rpm. These isolated misfires may occur if electrical noise that results from the rare overlap of certain ignition events exceeds the noise immunity of the ignition driver internal to the Powertrain Control Module (PCM).	Improved PCM
Ford/#1639	2001 Explorers	10,000	Some 2001 4.0L Postal Service Explorer trucks may have fouled spark plugs due to the ethanol percent calibration, low ambient temperatures, and frequent startup/ shutdown during the assembly process at the secondary manufacturer.	Unknown
Ford/#1768	2001 Mustang	32,000	Some 2001 3.8L Mustang passenger cars may experience spark plug fouling due to a combination of issues at the assembly plant, including improper engine priming at End-of-Line (EOL), high aromatic content premium fuels at EOL, excessive vehicle marshalling at the plant, and the incorrect use of an alternate in-plant engine calibration.	Unknown
Ford/#2403	2004 Mazda 3	37,000	Due to the nature of [the] spark plug, the spark plugs may be fouled when the vehicle is frequently running in a go-and-stop mode, such as in a heavy traffic. It may cause a hard to start engine and/or rough idle just after engine starting.	Unspecified repair procedure
Ford/#2471	2003 Mazda 6 2004 Mazda 6	60,000	Due to the nature of [the] spark plug, the spark plugs may be fouled when the vehicle is frequently running in a go-and-stop mode, such as in a heavy traffic. It may cause Malfunction Indicator Light (MIL) illumination, a hard to start engine and/or rough idle just after engine starting.	Unspecified repair procedure

Table 13: Defect Reports Relating to Spark Plug Operation (cont.)

Manufacturer and EPA Reference #	**Model Year and Model**	**# of Affected Vehicles**	**Defect Description**	**Remedy**
Ford/#2563	2005 Escape 2005 Mariner	131,400	Some 2005 model 3.0L Escape/Mariner trucks may have spark plugs that incur resistance deterioration creating a Radio Frequency Noise that damages the PCM/coil.	Improved spark plug
Ford/#2587	2005 Tribute	22,000	Some 2005 model 3.0L Mazda Tribute trucks may have spark plugs that incur resistance deterioration creating a Radio Frequency Noise that damages the PCM/coil.	Unspecified repair procedure
Ford/#2652	2003 Mazda 6 2004 Mazda 6	66,900	In certain driving conditions such as unstable combustion during engine warm-up (Engine coolant temperature is below 70 degree centigrade), and 6,000 rpm or above during full-throttle acceleration, exhaust gas in No. 5 cylinder may blow back into No. 4 cylinder due to variation of valve timing in combination with variation of exhaust manifold shape. It may result in misfire and Malfunction Indicator Lamp (MIL) illumination.	Unspecified repair procedure
General Motors/ #1844	2001 S10/Sonoma 2002 S10/Sonoma	123,929	Certain 2001 and 2002 Chevrolet S10 and GMC Sonoma 2WD trucks with the 4-cylinder 2.2L (L43) "flex-fuel" engines contain diagnostic calibration values that prevent the misfire diagnostic from illuminating the Malfunction Indicator Lamp (MIL) when the diagnostic has detected an engine misfire and the measured alcohol content of the fuel is greater than 5.9%.	Unknown
General Motors/ #2035	2002 Seville 2002 Deville 2002 Eldorado 2002 Aurora 2003 Seville 2003 Deville 2003 Eldorado 2003 Aurora	184,355	A misfire condition may occur in groups of four cylinders (1-7-4-6 or 2-3-5-8) . . . due to an[] incoherency between the PCM hardware and software.	Recalibration
General Motors/ #2167	2003 Trailblazer 2003 Envoy 2003 Vue 2004 Trailblazer 2004 Envoy 2004 Bravado 2004 Cavalier 2004 Sunfire 2004 Grand Am 2004 Alero 2004 Classic	15,102	Some spark plugs were produced with inadequate center electrode powder fill. This may result in voids in the conductive path inside the spark plug, leading to internal micro arcing and misfire.	Replace with good plugs when problem arises
Honda/#1738 & 1767	2001 Insight CVT	184	The misfire monitoring threshold was incorrectly programmed so that no misfire will be detected during a limited period of idling after cold engine start. The lowest engine speed for misfire monitoring was incorrectly programmed so that misfire may not be detected when engine speed is lower than the normal idle speed.	Unknown
Honda/#1924	2001 NSX	167	The igniter and the ignition coil may be damaged when the ignition key is left at the on position after the starter is operated briefly. The failure will cause one cylinder to cut firing continuously. The MIL illuminates.	Unspecified "counter-measure"

Table 13: Defect Reports Relating to Spark Plug Operation (cont.)

Manufacturer and EPA Reference #	Model Year and Model	# of Affected Vehicles	Defect Description	Remedy
Honda/#1925	2001 S2000 2002 S2000	17,687	The spark plug gasket is crushed and the spark plug tightening torque is lost so that it will loosen. Misfire will occur, idling will be unstable, and the MIL will turn on.	Improved spark plugs
Honda/#1956	2002 CRV	8,598	Under idle conditions with no load applied after engine is fully warmed-up, the OBD monitoring system may falsely overlook misfire. When an electrical load such as Head-Light exist, the OBD monitoring system correctly detects misfire.	Unknown
Honda/#2051	2003 Civic IMA	23,454	Single intake plug malfunction can be detected by misfire monitoring system under specific conditions such as cold start idling. Malfunction of single exhaust plug may not be detected by misfire monitoring but emission impact is smaller than when malfunction occurs in the intake plug.	Recalibration
Honda/#2474	2001 Civic 2002 Civic 2003 Civic	888,941	The flow of some fuel injectors may decrease due to contamination during the manufacturing process. The MIL illuminates for misfire.	Improved fuel injectors
Toyota/#1575	2001 LS430 2001 GS430	14,000	MIL illumination related to misfire (P030) due to unstable combustion, only when low RVP fuel is used.	Recalibration
Toyota/#1605	2001 Camry 2001 Solara	73,000	MIL illumination related misfire (P030) due to unstable combustion.	Recalibration and injector replacement
Toyota/#1903	2002 IS300 2002 GS300	32,000	MIL illumination related misfire (P030) due to unstable combustion when low RVP fuel is used.	Recalibration
Toyota/#2116	2001 MR2 2002 MR2 2003 MR2	14,000	MIL illumination related misfire (P030) due to unstable combustion just after cold start with low volatile fuel.	Recalibration
Volkswagen/ #1973	2002 Passat	44,539	A combination of engine tolerances and fuel quality can cause the misfire threshold to be reached after cold start.	Recalibration
Volkswagen/ #1975	2001 Beetle 2001 Passat 2001 EuroVan 2001 A4 2001 TT 2002 A4 2002 Audi V6 2002 TT 2002 A6 2002 Beetle 2002 Golf 2002 GTI 2002 Jetta 2002 Passat 2002 EuroVan 2003 A4 2003 Audi V6 2003 A6 2003 Cabrio 2003 Beetle 2003 Golf 2003 Jetta 2003 GTI 2003 Passat 2003 EuroVan	455,199	One or more of the vehicle's individual ignition coil(s) may become inoperable causing the engine to misfire and illuminate the Malfunction Indicator Lamp (MIL).	Improved ignition coil

Table 13: Defect Reports Relating to Spark Plug Operation (cont.)

Manufacturer and EPA Reference #	**Model Year and Model**	**# of Affected Vehicles**	**Defect Description**	**Remedy**
Volkswagen/ #2045	2001 Jetta/GTI 2001 Beetle 2002 Jetta/GTI 2003 Jetta/GTI	186,562	A combination of engine tolerances and fuel quality can cause the misfire threshold to be reached after cold start.	Recalibration
Volkswagen/ #2137	2003 A6 2003 Allroad	1,782	One or more of the vehicle's individual ignition coil(s) may become inoperable causing the engine to misfire and illuminate the Malfunction Indicator Lamp (MIL).	Improved ignition coil
Volkswagen/ #2545	2005 A4 2005 Cabriolet	2,874	Vendor quality issue with the production of spark plugs.	Replace spark plugs
Volkswagen/ #2639	2006 Passat	25,960	The intake manifold control motor can stop operating in any position of its designed travel. If the motor stops operating with the vane in the closed position, there is the potential of customer complaints of cold start misfire.	Improved intake manifold control motor
Total		**3,068,315**		