Eastern Research Group, Inc.

Enhancements to On-Board Diagnostics Components of the Inspection and Maintenance Program

FINAL REPORT

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Prepared by:

Eastern Research Group, Inc.

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Final Report

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1.0 Executive Summary

Eastern Research Group (ERG) was asked to undertake this work to explore strategies and ideas for enhancing the On-Board Diagnostic (OBD) inspection component of the Texas Inspection and Maintenance (I/M) program in the coming years.

Section Three of this report focuses on improvements which can be made to OBD system auditing, analysis of additional vehicles which might be candidates for the OBD test, and descriptions of other research performed in an effort identify other program improvement options. A short list of program options are discussed that could be considered in the OBD program by the Texas Commission on Environmental Quality (TCEQ) in the future such as enhancements to the OBD analyzer audit procedures, changes to "readiness" criteria on retests for catalytic converter and evaporative system failures, testing of light-duty diesel vehicles, and testing medium- and heavy-duty vehicles. There is also discussion on a broad range of OBD enhancements for which ERG believes the current procedures and practices in place are satisfactory at this time. These include testing of controller area network (CAN) vehicles, OBD test procedures for keyless ignition, hybrid and alternatively-fueled vehicles, model year (MY) exemptions, gas cap testing and configurable program tables.

A number of enhancements which can be made to the OBD inspection equipment or software in order to identify and prevent fraud are covered in Section Four. Many of these steps may be used to identify fraud in real-time and prevent a fraudulent test from being conducted, as opposed to collecting data fields which are then post- processed to identify fraud after it has occurred. Included in this review are topics such as verification of the vehicle's software calibration identification numbers, evaluation of the vehicle monitor supported profile and vehicle OBD communication protocol. The collection / monitoring of live data such as engine speed during an OBD test could also be used to deter fraud, although some of these changes would require software upgrades.

Section Five provides analyses of existing program data from the Texas Information Management System (TIMS) and trigger data developed by the program contractor to help further reveal fraud and noncompliant testing which has already taken place. This is a continuation of the fraud and non-compliance analysis presented in the 2009 program evaluation report[1]. A number of analyses are provided that outline how the data that is currently collected could be used to help reduce the likelihood of fraudulent OBD tests being performed. These analyses indicate that the current triggers system does indeed provide a useful tool for identifying suspicious testing behavior. Additional analyses using the TIMS data also provide additional supporting evidence of inappropriate testing practices that include non-compliant testing and fraudulent testing. Improvements that would help reduce non-compliance include requiring the entry of repair information rather than "MISC" in the test record, adding an algorithm to verify the check digit of the vehicle identification number (VIN), and requiring the use of barcode scanners to minimize incorrect VIN entries. Some of the recommendations for addressing test fraud include a real-time check of the electronic VIN (eVIN) from all 2005 and newer vehicles with the VIN in the test record, an analyzer functionality feature that would prevent a vehicle's weight being changed from below 8,501 pounds to above 8,501 pounds to below 8,501 pounds on retest, requiring inspectors to enter a comment in the test record for vehicles tested, repaired and then retested in less than 20 minutes, and considering the implementing methods to monitor or record live data parameters to identify and prevent the use of OBD emulators and OBD simulators. A complete list of recommendations resulting from the analyses in Section 5 may be found in Section 5.4.

It should be noted that the cases found in this study of what appear to be fraudulent testing may or may not be under investigation at this time. ERG is not involved in any such investigations and hence not able to comment on whether the existing trigger data is being used appropriately and efficiently to track down cases of OBD test fraud.

2.0 Introduction

Under the provisions of the Federal Clean Air Act, the Texas Commission on Environmental Quality (TCEQ) adopted rules establishing Texas's vehicle inspection and maintenance (I/M) program. The adopted rule in 30 Texas Administrative Code §114.50 requires annual emissions inspections for all gasoline-powered motor vehicles whose model-year is two through 24 years old and are registered and primarily operated in an I/M county.

The United States Environmental Protection Agency (EPA) regulations state that all model-year 1996 and newer gasoline-powered vehicles with a gross vehicle weight of 8,500 pounds or less, all model-year 2007 and newer vehicles with a gross vehicle weight of 8,501 pounds to 14,000 pounds, and all model-year 2013 and newer vehicles with a gross vehicle weight over 14,000 pounds must be equipped with an OBD system. The OBD system monitors the performance of a vehicle's powertrain and emissions control systems and is equipped with a standardized data link connector (DLC) used to communicate with OBD scan tools and vehicle emissions inspection analyzers.

In 2001, the TCEQ adopted rules requiring OBD inspections on all model-year 1996 and newer light-duty gasoline-powered vehicles participating in the I/M program, which includes the counties of Brazoria, Collin, Dallas, Denton, El Paso, Ellis, Fort Bend, Galveston, Harris, Johnson, Kaufman, Montgomery, Parker, Rockwall, Tarrant, Travis, and Williamson. All inspection stations participating in the I/M program must perform an OBD inspection during the annual safety and emissions inspection conducted on 1996 and newer light-duty gasoline-powered vehicles. Vehicles older than 1996 are given an Acceleration Simulation Mode (ASM) or Two-Speed Idle (TSI) tailpipe test.

As a greater percentage of the vehicle fleet subject to the Texas I/M program becomes model year 1996 or newer, the percentage of OBD tests relative to ASM or TSI tests increases. As reported in the 2009 program evaluation report ERG recently prepared for TCEQ, approximately 81% of the tests conducted over the reporting period were OBD, 16% were ASM, and 2% were TSI. This compares with the 2006 report's figures of 67% OBD tests, 30% ASM tests and 3% TSI tests, reflecting an expected increase in the OBD percentage of vehicles in the fleet[2]. The percentage of vehicles which will receive OBD tests (relative to ASM or TSI tailpipe tests) will continue to increase as more and more of the fleet is comprised of 1996 and newer vehicles. This increase in OBD testing is seen across the country, with the exception of states (such as Colorado) still conducting tailpipe tests on 1996 and newer vehicles. However, although the number of OBD tests relative to tailpipe tests is increasing in the Texas I/M program (and in most programs), tailpipe testing may still have a role in testing pre-1996 vehicles (which are not yet 25 years old or older), as well as a fallback test for vehicles which are not OBD-testable. In addition, retaining the tailpipe test allows actual emission measurements to be performed for program evaluations and compliance reporting.

Because of the growing number of vehicles subject to OBD inspections, the market has grown for systems, devices and methods to manipulate the OBD test in order to conceal non-compliant equipment or vehicle malfunctions. These methods of fraud may range from strategically-timed monitor resets to mask certain types of malfunctions (typically catalytic converter or evaporative system failures) to devices such as post-catalytic converter oxygen sensor simulators or even complete OBD system emulators which entirely replace the vehicle's DLC with one that transmits user-input parameters during a vehicle inspection. Inspection fraud also continues to be a threat through fraudulent inspector practices such as clean-scanning or even the use of OBD simulators.

Fortunately, although a greater market incentive exists for OBD fraud, OBD systems have also evolved with enhanced fraud detection and prevention capabilities. The overall intent of this project was to identify methods for improving the effectiveness of the OBD inspection component of Texas' I/M program, in part by taking advantage of these developments in OBD system technology and also by taking advantage of the increase in prevalence of OBD in various types of on-road vehicles. In addition, for this work order we've also developed new data analysis techniques which can be used to identify various types of fraud and noncompliance in I/M OBD data.

3.0 OBD Program Enhancements

ERG evaluated the OBD component of the Texas I/M program to in order to identify ways of improving the program's effectiveness, both in terms of how the test is administered and in terms of emission reduction benefits. Particular emphasis was placed on auditing the OBD program's analyzers, but the following other topics were also considered during this evaluation: count of not-ready monitors which are allowed, OBD testing of light-duty diesel vehicles, OBD testing of medium-duty and heavy-duty vehicles, OBD testing of vehicles which use the CAN communication protocol, OBD testing of vehicles with keyless ignition, OBD testing of hybrid vehicles, OBD testing of alternatively-fueled vehicles, model year exemptions and gas cap testing.

During this evaluation, ERG reviewed Texas' I/M program audit procedures and the type of information that is collected during OBD system audits, the 2006 and 2009 Texas I/M program evaluation reports ERG previously prepared for TCEQ and the "Specifications for Vehicle Exhaust Gas Analyzer Systems for Use in the Texas Vehicle Emissions Testing Program" (Texas Analyzer Specification). In addition, ERG reviewed the Weber State OBD Clearinghouse (http://www.obdclearinghouse.com) and talked with administrators and technical contacts from various I/M programs including Nevada, Arizona, Utah, Georgia, Oregon, North Carolina, Maryland, California, Massachusetts, New York and Missouri to compare what other states are doing relative to the Texas program. The results of this review on each of these topics are presented below.

3.1 OBD Analyzer Auditing

As described in ERG's 2006 I/M program evaluation, overt audit procedures are outlined in Texas' Inspection and Maintenance state implementation plan (SIP). These audit procedures were evaluated in the 2006 program evaluation, and as listed in the 2006 report, both administrative and compliance audits include some facet of OBD system evaluation, although OBD-related information for each of these types of audits is limited to a response of whether or not the station has "operational OBD equipment". Files for both of these types of audits are stored in the Texas auditor system database (TAAS). Furthermore, no OBD-specific information is contained in "Perform.dat", the analyzer audit file from the TIMS.

As described in the 2006 program evaluation report, neither the Texas SIP, the Code of Federal Regulations nor the Texas Department of Public Safety (TxDPS) auditor training video contain OBD-related audit procedures, and OBD system functionality is not evaluated during overt audits. ERG discussed this with TCEQ personnel who confirmed that overt OBD audit results beyond those described above are not collected or available. TCEQ personnel do have the ability to assess the performance of the OBD inspection analyzers by performing tailored queries of vehicle inspection data in order to identify analyzer performance issues. Covert audits may also identify hardware malfunctions, to an extent, and overt auditors could assess OBD system performance during an onsite visit.

From discussions with other states, OBD equipment audit procedures were seen to range from no hardware checks being performed during an audit to OBD scanner checks being performed before and after every OBD inspection. In general, most OBD equipment testing was done during the course of normal daily activities (rather than during auditor inspections), and initiated by processes integrated into the analyzer software.

Based on our review, some options for OBD audit program enhancements could include:

- Enhance OBD test equipment visual inspections during audits - Visual inspection of the OBD test equipment, in particular inspection of the DLC cable to ensure it is a manufacturer-approved cable, is recommended during all overt audits. The use of off-brand replacement DLC cables appears to increase the likelihood of analyzer communication failures in other programs.

- Conduct an OBD scan during an overt audit - Overt auditors may use their audit vehicles or a handheld OBD simulator to ensure the OBD analyzer communicates effectively and produces appropriate outcomes for various test scenarios. Since different DLC pins are used for different communication protocols, it is possible for an OBD analyzer with a faulty cable or DLC contact pins to successfully communicate using one protocol but fail to communicate with another protocol. Therefore, use of an OBD simulator (or communication protocol checker) is preferable to use of the auditor’s vehicle, as this allows the auditor to test the OBD analyzer against multiple communication protocols, and also to tailor settings for readiness, DTC storage, MIL command status and even collection of Mode $09 data (vehicle identification data) during auditing.

- Require vehicle inspectors to verify scanner performance – Through the use of software, some I/M programs require vehicle inspectors to verify the functionality of their scanners during the regular testing routine (prior to or after an inspection) or periodically during the day (similar to a 4-hour audit performed on a gas bench). This inspector-based testing is typically limited to checking connectivity of various pins across the DLC cable, but this type of system verification may be more common in centralized programs than decentralized programs, due to the additional inspector time involved. If Texas were to adopt this methodology, system verification could be required by the analyzer, either periodically during the day, as part of the OBD test routine, or it could be required as part of a test sequence when a “failure to communicate” was occurring for reasons other than missing, unable to locate, or damaged vehicle DLC. A system check could be required before the vehicle was failed for “failure to communicate”. Analyzers could be modified to include a “loopback tester” which would test the connectivity of the various DLC pins, or a remote (handheld) connectivity tester could be used.

3.2 Not-Ready Monitors Allowed

As with most states interviewed for this work order, Texas follows EPA’s guidance of allowing two unset readiness monitors for model year 1996 – 2000 vehicles, and one unset readiness monitor for 2001 and newer vehicles. As noted in the 2009 program evaluation, this was a change implemented in October 2008. We recommend no changes in the number of unset readiness monitors allowed in the program.

However, as discussed in the 2006 and 2009 program evaluation reports, unset readiness monitors can potentially “hide” malfunctions in recently repaired vehicles. Therefore, when a future software change is required for the Texas analyzers, we recommend TCEQ implement an analyzer software change that would require certain monitors to have a “ready” status on an OBD retest, based on the initial failure category. In particular, the evaporative system monitor would need to be “ready” for a successful retest of an evaporative emission control system failure (DTCs in the range of P0440 - P0455) and the catalytic converter monitor would need to have a “ready” status for a successful retest of a catalytic converter failure (DTCs in the range of P0420 – P0434). Enforcing monitor-specific readiness on certain retests would help confirm effective repairs had been made for these specific system failures.

3.3 OBD Testing of Light-Duty Diesel Vehicles

In the Texas I/M program, emissions tests are not performed on diesel vehicles. However, the Texas inspection analyzer and TIMS database do use a configuration table which includes a diesel testing option, allowing diesel testing to be added to the inspection program with relatively little effort.

In October 2008, ERG submitted a report to the TCEQ entitled “Estimates of Emission Reductions from Performing OBDII Tests on 1997 and Newer Diesel Vehicles up to 14,000 lbs GVW”[3]. In this report, ERG explored the possibility of TCEQ adding an OBD inspection component to the Texas I/M program and estimated the emission reduction benefits that could result from that addition, based on MIL illumination rates and stored DTCs seen in other programs, and presumed emissions benefits from certain repairs based on the stored DTCs. Based on the analysis and assumptions outlined in that report, HC and PM emissions from LD diesels were estimated to be reduced by approximately three percent and NOx emissions were estimated to be reduced by approximately one quarter percent by performing OBDII inspections on 1997 and newer light-duty diesel-powered vehicles weighing less than 8501 pounds. Mobile6 runs were then used to develop county-based emissions reduction estimates for calendar years 2009, 2012 and 2018 based on those presumed emissions reduction benefits, and these modeling results are also included in the report. Depending on the county, annual NOx reductions were estimated to be up to 0.6 tons, annual HC reductions were estimated to be up to 2.6 tons, and annual PM reductions up to 0.09 tons. Although the estimated emission reductions are small, the significance of the values really is dependent on the level of reductions needed to meet SIP requirements.

Only two of the seven states ERG spoke with about diesel testing performed OBD testing on diesel vehicles (14,000 lbs and under). One state reported that since diesels typically have fewer monitors than gasoline-powered vehicles, applying gasoline readiness criteria generally resulted in diesel vehicles being always "ready" when a test was conducted. Therefore, if implementing diesel testing, we recommend considering only allowing one or no unset readiness monitors for a diesel vehicle to achieve "readiness". Additional review of diesel monitors in I/M data from other programs or review of "phase-in" diesel monitor data in Texas (if diesel testing is implemented) could be performed to tailor diesel readiness criteria for the Texas program.

3.4 OBD Testing of Medium-Duty and Heavy-Duty Vehicles

Per the Texas analyzer specification, visual MIL results rather than downloaded OBD data are used for pass / fail determinations on gasoline-powered vehicles with a gross vehicle weight over 8500 pounds. Results of this visual inspection are manually entered into the analyzer (not downloaded). Diesel vehicles over 8500 pounds GVWR are not tested. For this subsection, ERG investigated using downloaded OBD data for pass/fail determinations for gasoline and diesel vehicles with a GVWR over 8500 pounds in the Texas I/M program.

Beginning with model year 2004 and phased in by model year 2007, EPA regulations require all medium-duty vehicles (8501 – 14,000 pounds GVWR) be equipped with OBDII compliant systems which use the ISO 15765-4 (controller area network) communication protocol (65 FR 59896). Furthermore, EPA regulations require OBD phase-in to begin for heavy-duty gasoline and diesel-fueled vehicles (over 14,000 pounds GVWR) beginning with the 2010 model year. By 2013, the phase-in would be complete for all highway engines and all manufacturers (EPA420-F-08-032). However, it should be noted that the EPA regulations requiring CAN usage on vehicles with GVWRs between 8,501 and 14,000 pounds does not apply to vehicles currently using the SAE J1939 communication protocol. Therefore, it is possible that some of the vehicles in this medium-duty weight range would not be equipped with the SAE J1962 diagnostic connector (standard OBDII DLC) and would therefore not be testable in the Texas I/M program. A fallback option (such as a visual MIL check) would be necessary for these vehicles.

Two of the seven states ERG spoke with did perform OBD testing on vehicles over 8500 pounds GVWR. Both of these states limited testing to model year 2008 and newer vehicles with GVWRs between 8501 and 14,000 pounds, and neither reported any significant issues arising during implementation of the diesel testing program.

At this point in time, because of the lack of standardization prior to model year 2008, ERG does not recommend OBD testing medium-duty vehicles (8501 – 14,000 lb GVWR) older than model year 2008, and a fallback test (such as a visual MIL test) would be needed for any vehicles using an SAE J1939 system. Therefore, OBD testing of medium-duty vehicles would yield only a small portion of the fleet to the I/M program, and this would be a cleaner portion of the vehicles in this weight range. Furthermore, ERG does not recommend implementing OBD testing of heavy-duty vehicles (14,001 lbs GVWR and heavier) until the model year 2013 vehicles are eligible for inspection, at the earliest. As with light-duty diesel testing, ERG recommends tailoring the readiness criteria for diesel-powered vehicles differently than for gasoline-powered vehicles.

3.5 Program Facets for which No Changes Are Recommended

In addition to the above issues, several other OBD program issues were evaluated in order to identify any improvements which could be made to the Texas program. ERG is not recommending any changes to the Texas program based on review of the following issues.

3.5.1 OBD Testing of Vehicles with Controller Area Network (CAN) protocol

EPA regulations (68 FR 35972) require that all MY 2008 and newer light-duty vehicles (GVWR of 8500 lbs or less) communicate via ISO 15765-4, also referred to as controller area network (CAN) protocol. However, many pre-2008 vehicles are also equipped with CAN. I/M program emission analyzers must communicate using the CAN protocol in order to allow this growing segment of the fleet to be tested.

CAN-testing capability has already been incorporated into Texas' I/M program. During our discussions with other states, ERG asked about their CAN implementation experiences to try to gather information which might also be helpful for the Texas program. Six of the seven other states with whom we spoke also are testing CAN-equipped vehicles, and offered the following information:

During implementation of CAN testing, apparent signal-timing issues resulted in a higher failure-to-communicate rate than expected. For those states where this was a problem, these issues were resolved through software upgrades. Some states also stressed the importance of distinguishing between 11-bit and 29-bit vehicles when downloading vehicle information via the CAN protocol (Texas distinguishes between 11 bit and 29-bit communication protocols and records this information in the test record). Regarding failure-to-communicate rates, ERG reviewed Texas' analyzer communications rates by make, model and model year and analyzer manufacturer in the 2009 program evaluation report, with emphasis on identifying problems associated with CAN communication. As shown in that report, the rate of communication problems was relatively low using different evaluation criteria, suggesting no significant problems are occurring with CAN communication. Additional information on communication rates seen in the Texas program is also presented in Section 5.2.1 of this report.

3.5.2 OBD Testing of Vehicles with Keyless Ignition

Due to lack of "key on, engine off" control, visual MIL (bulb check) tests can be problematic for vehicles with keyless ignitions. This portion of the test should be bypassed for vehicles with keyless ignition. According to the Texas analyzer specification, the visual MIL bulb check is in fact bypassed during the OBD test on keyless ignition vehicles. No changes are recommended.

3.5.3 OBD Testing of Hybrid Vehicles

Since hybrid vehicles may not provide an RPM signal during the OBD download portion of the inspection, the Texas analyzer specification allows the inspection analyzer to bypass the RPM signal requirement during OBD tests on hybrid vehicles. No changes are recommended.

3.5.4 OBD Testing of Alternatively-Fueled Vehicles

In Texas, OBD testing is performed on gasoline vehicles (or dual-fueled vehicles capable of operation on gasoline). Diesel and alternatively-fueled vehicles not capable of operation on gasoline are not OBD tested. Approximately half the states we spoke with perform OBD testing on alternatively-fueled vehicles. Although no changes are recommended at this time, additional investigation at a later date may be beneficial in determining the percentage of vehicles in the Texas fleet that are alternatively-fueled and the emission benefit that would be achieved by including them in the I/M OBD test program.

3.5.5 Model Year Exemptions

Texas exempts the first two model years of new vehicles. Because of the relatively low fail rates and emissions of these vehicles, no changes are recommended for this exemption.

3.5.6 Gas Cap Testing

In Texas, independent gas cap testing is performed during the OBD inspection. Because of the potential evaporative benefit achieved by gas cap testing, and since gas cap testing does identify failing gas caps for vehicles which have no evaporative DTCs stored, we recommend retaining the gas cap test.

3.5.7 Configurable Program Tables

Texas currently uses configurable system tables in order to maximize program flexibility. For example, revisions to configurable analyzer tables such as TXVRT.DAT and SYSTEM.DAT may be transmitted from the VID to the Texas analyzers to implement program changes without software updates. TXVRT.DAT changes are used to specify vehicle test parameters such as makes to exempt from the OBD test and OBD monitor requirements, and SYSTEM.DAT is used to specify county-based program parameters such as types of tests administered, applicable model years for various types of tests, fuel types to be tested, diesel testing, heavy-duty vehicle testing, hybrid and keyless vehicle testing and monitor and readiness requirements. By using these tables (and other configurable analyzer/VID tables), the Texas I/M program can encourage the implementation of program changes to target locations as needed without a costly and time-consuming software change.

4.0 Fraud Detection and Prevention

Texas currently collects several parameters which can be (and are) used for fraud identification. These include the powertrain control module identifier (PCM ID) and its associated parameter ID (PID) count (Mode $01 request for in-use monitor count) as well as the eVIN (Mode $09 vehicle identifying data). Section Five of this report describes analysis which can be performed with I/M data in order to identify fraud, and this topic is also discussed in the 2006 and 2009 Texas I/M program evaluation reports. The remainder of this section discusses enhancements which can be made to the OBD inspection analyzer or software in order to identify and prevent fraud. Many of these steps may be used to identify fraud as it is happening and prevent a fraudulent test from being conducted, rather than collect data fields which can be used to identify fraud after it has occurred.

4.1 Verify Calibration ID and CVN

Additional information which can be collected from 2002 and newer vehicles' OBD systems to aid in fraud prevention include the Calibration ID (PCM or software ID number) and CVN (Calibration Verification Number), which is the checksum of the calibration ID. Both of these Mode $09 parameters may be used to verify the integrity of the vehicle software, which can help identify non-compliant onboard computer re-flashes, OBD system emulators or clean scanning. However, because of the onboard reprocessing required, collection of the CVN may result in a slight test delay as it is calculated by and downloaded from the vehicle's onboard computer, and some vehicles may require an engine shut-off in order to collect the CVN.

Although the Calibration ID and CVN should be available from the ECM for all 2002 and newer vehicles, it is unlikely it can be used as a "real-time" fraud identification tool until a comprehensive database of valid Calibration IDs and CVNs based on vehicle make, model and model year is available or can be developed from historical I/M data. Until that time, ERG recommends collecting this data as part of the I/M inspection in order to develop such a database of valid Calibration IDs and CVNs that could facilitate near real-time detection of fraudulent inspections in the future.

4.2 Evaluate Monitor Patterns and Communication Protocol

As discussed in ERG's 2006 and 2009 Texas I/M program evaluation reports, the unique pattern of monitors which are supported or not supported may be used to help identify potential fraud (clean-scanning or the use of OBD emulators). In fact, as described in Section 5.1 of this report, Texas currently uses vehicle monitor support signatures in existing I/M data as a trigger to identify potentially fraudulent testing, so many of the steps described in this section may already be in place.

In general, supported monitor patterns are generally relatively standard for any combination of make/model/model year vehicle. As does Texas, another state we spoke with decodes the vehicle's VIN and looks up and compares the anticipated monitor pattern (based on that vehicle's VIN) with the monitored pattern of the tested vehicle in an effort to identify potential fraud. Comparisons should also be made between type of vehicle and the communication protocol used by that vehicle in order to further help identify clean-scanning or the use of OBD emulators. As with Calibration ID and CVN, a database that contains monitor patterns (such as Texas' "truth table" using VIN stem) and communication protocols by vehicle type can be used to identify (and perhaps prevent) attempted fraud as it is occurring. Commercially available resources are also available which provide vehicle-specific monitor support signatures and communication protocol information. In addition, existing I/M data (and publicly-available communication protocol data) may continue to be used to maintain vehicle-specific monitor pattern and communication protocol tables in-house, if desired. It should be noted, however, that monitor patterns may vary, even among same model year / model vehicles. This is particularly true for pre-2000 model year vehicles. Care should be taken to not block legitimate tests for vehicles with monitor patterns which differ from "expected" patterns for those vehicle types. Numerical approaches for using monitor patterns as a fraud prevention tool without inadvertently blocking legitimate tests are used in other programs and could be developed for Texas, if needed.

4.3 Compare OBD VIN with Inspector-Entered VIN

The OBD VIN should become more reliable as a greater percentage of the vehicle fleet becomes model year 2005 and newer vehicles. For these newer vehicles, the OBD VIN may be compared with the VIN entered by the vehicle inspector to identify potential clean-scanning. Texas is already using the OBD VIN as a trigger (eVIN) as discussed in Section 5.1 of this report.

4.4 Monitor Live Data Parameters

Other enhancements may also be made to the inspection process (by way of analyzer software updates) or data analysis techniques in order to identify clean scanning, OBD emulators, or other types of fraud. As explained by Mike McCarthy of the California Air Resources Board, more active tests could be integrated into the analyzer software in order to identify vehicles that may be equipped with OBD emulators. These could include checks for certain vehicles with suspicious OBD parameters (such as an invalid or missing CVN) or for vehicles where emulator use is expected to be more common. Additionally, the inspector may be required to increase the vehicle's throttle and hold the engine speed at an elevated RPM (revolutions per minute) for a period of time; watching for responses in one or more of the live data parameters. Various parameters could be monitored, including calculated load, short-term fuel trim, ignition timing, RPM, throttle position sensor position, fuel pressure, mass air flow rate or manifold absolute pressure, or other fluctuating parameters which are dependent on engine speed. In addition, a more passive monitoring approach could include simply programming the analyzer to monitor a number of these parameters while the engine is running during the OBD download process. Unchanging (static) values for parameters which should slightly fluctuate at idle (mass air flow, short-term fuel trim, RPM, etc.) would suggest the vehicle is equipped with an emulator, which could trigger additional investigation or more "active" testing (such as the inspector depressing the throttle). One approach for monitoring these parameters might be to select two parameters, and require at least one to change (any amount) within a set time period (such as 5 seconds). The fluctuation tolerance should not be important, as the test would merely be attempting to distinguish between pre-programmed static values and live parameters (so a change in RPM from 700 to 701 would be sufficient, or a change of short-term fuel trim from 1.3 to 1.4 would be sufficient). The monitored parameters and the duration (in seconds) of monitoring for a change should be updatable through an analyzer configuration file.

Data collection and analysis of the parameters described above may provide information on how this data can best be used for fraud prevention. After a reasonable amount of data has been collected, analysis may be performed in order to determine which of the queries described above could best be integrated into the Texas I/M program. If attempting to prevent fraud before it happens, a strategy is required on how to prevent the test from proceeding (reject the vehicle from inspection, abort the inspection, fail the inspection) and how to direct the motorist from that point. One possibility would be to direct the motorist to a special station (such as a TxDPS-operated station) where additional testing would be required (i.e., by TCEQ or DPS employees) before the vehicle could pass the inspection and receive a certificate. During this special test, investigation would be performed in order to ensure the vehicle is OBD compliant.

5.0 Detecting Fraud and Non-Compliance

In this section we will discuss the results of several different methods for evaluating the quality of OBD I/M inspections. This will include a review of the "triggers" that are used to identify I/M stations that are performing non-compliant inspections, an investigation of the TIMS dataset to determine whether OBD inspection information that is recorded is consistent with specifications, an investigation of non-compliance with OBD inspection protocols by I/M stations and inspectors using TIMS data, and an investigation of potentially fraudulent OBD inspections that may be identified using TIMS data.

5.1 Triggers Analysis

In the 2009 I/M Evaluation report, ERG examined station triggers for two years (2007 and 2008) of the Texas TIMS data. The primary goal of that analysis was to look at the existing triggers data from a different perspective that could serve as a comparison to how the triggers data are currently being analyzed. It was not the goal to establish one method as "right" or "superior", but rather to see if different views of the same data would yield any further insight with regard to detecting station fraud.

The work in this report extends that analysis; therefore, the results from the 2009 report are summarized below. Because the future of all I/M programs will become more focused on the OBD fleet as the older vehicles are retired, additional attention was given to analyzing the details of the electronic VIN (eVIN) and readiness monitor trigger data to determine if these triggers could provide further information for detecting and/or deterring fraud during an OBD test.

Four triggers were examined in the 2009 report that used two years of station data to look for evidence of station fraud. The four triggers were electronic VIN (eVIN), readiness, emission failure and 96tp. The eVIN metric is based on test records where the OBD eVIN does not match the inspector-entered VIN. Mismatches occur due to manual or barcode VIN-entry errors or because of possible clean-scanning. It should be noted that prior to MY05, eVINs were not standardized across all makes and models, so this trigger may be less of valuable on the older MY96-04 vehicles. Separating the eVIN population into MY96-04 and the MY05 and later would remove the possibility of a demographic bias that could result from some stations testing predominantly older vehicles.

The readiness trigger is based on a comparison of the supported/unsupported readiness monitor signature of a given vehicle with that particular vehicle's "truth table" signature based on its VIN stem. Again, as with eVIN, mismatches suggest possible clean-scanning. The 96tp trigger is based on test records of MY96 and newer vehicles that received a TSI tailpipe test rather than an OBD test. High values here may be indicative of fraud by testing OBD-equipped vehicles using a TSI test which would not detect certain OBD failures. The Emission Failure trigger compares the average emission failure rate for a station to the average failure rate for the entire network. High values could be indicative of inspectors falsely-failing vehicles, while low values could signify vehicles are receiving false-passes. This trigger could be applied to both OBD and non-OBD tests.

The method developed in the 2009 study used a metric such as an average +3 standard deviations to flag suspect stations because it was found to be more robust than the decile values that are calculated. The reason for this was believed to be that the triggers data contain inspection results from referee or government run stations that have atypical failure rates or mismatch values, and these values tend to skew the decile values much more than they skew the average +3 standard deviation values. Some of these referee and government stations were identified and removed from the data set, but it was not necessarily clear when a station was a referee or government station, and therefore some of these stations were likely inadvertently left in the dataset, skewing the results."

For each of the four triggers listed above, an annual average and standard deviation were calculated using all records for each trigger. A station was flagged as potentially performing fraudulent inspections if its metric exceed the annual average plus 3 standard deviations in both 2007 and 2008. The 3 standard deviation metric was somewhat arbitrary, but it was found to be an acceptable data-screening tool for this analysis. For the eVIN, Readiness, and 96tp triggers, only high values are indicative of suspicious behavior; however, with the Emissions Failure trigger, both high and low values may be significant. Therefore, for the Emissions Failure trigger, stations were flagged if they were three standard deviations above the average, or if they were one standard deviation below the average (two and three standard deviations below the average were less than zero, and not useful as indicators). For the Emissions Failure and 96tp triggers, estimates to roughly categorize the test volume for a given station were also made. Tables 5-1 through 5-5 summarize the results of this analysis. Note that we attempted to remove TxDPS stations from the analysis based on a list of government stations that was provided, but in Table 5-4 there were still some stations being flagged that should probably not be included in the analysis. Additional analysis of results shown in Tables 5-1 through 5-5 is provided in Section 5.3.

Table 5-1. Stations with High eVIN Trigger Values

Station ID	Station	2 yr avg Mismatch
1P36597	JESUCHISTRO TIRE SHOP	99.52%
1P37432	CITY PRE OWNED	99.47%
1P34167	EXCEL AUTO CENTER	92.74%
2P36491	JS MOTOR	92.10%
1P37231	SERGIOS ALIGNMENT	90.98%
1P36208	MOCKINGBIRD STATE INSPECTION & REP	86.08%
1P32428	CICO TIRES	85.04%
1P36692	KELS AUTOMOTIVE	83.70%
1P33861	LINDAS STATE INSPECTION #2	83.47%
4P32677	C & E AUTO SERVICE	81.88%
4P33140	EL PASO COLLISION CENTER	81.43%
1P35854	LANCE AUTO REPAIR	77.06%
1P27736	LINDAS STATE INSPECTION	77.05%
1P18012	FERS ALIGNMENT BRAKES & MUFFLERS	75.93%
1P37414	JC`S AUTOMOTIVE CENTER	75.86%
1P33344	MARTINEZ AUTO DETAIL & STATE INSPE	70.69%
4P28171	L A AUTO CLINIC	68.56%
1P32363	GUZMAN MOTORS & TIRES	67.68%
1P36641	GREGS INSPECTIONS	66.65%
1P35091	LINDAS STATE INSPECTIONS #3	66.55%
1P36998	GERS BRAKE SERVICE #3	66.17%
2P34869	PASADENA AUTO COLLISION CENTER INC	64.03%
4P37684	AUTOBAHN COMPLETE CAR CARE CENTER	60.76%
1P35240	A & I AUTO RECYCLERS	60.39%
4P37802	AUTO CORDOVA ELECTRIC	59.87%
1P32181	HINGAS AUTOMOTIVE CO	59.79%
1P37190	MS TIRES AND WHEELS	57.39%
1P32094	TRI-C TIRES & WHEELS	55.93%
2P34516	QUICK STOP INSPECTION	52.68%
1P25321	PETRIE AUTO SALES INC	50.84%
1P28394	OVERSEAS SERVICE HAUS INC	49.51%
1P25610	BRONCO GARAGE	48.88%
1P35822	DRIVERS SELECT	46.72%
2P34452	CORONA CAR CORP	45.83%
1P37182	YOSIAS AUTO SERVICE & REPAIRS	45.78%
1P37422	DUHA GARAGE	44.91%
1P35523	ERNEST TIRE SERVICE INC	44.80%
2P25744	PARSEE AUTO	44.29%
1P37841	CHAMPION AUTO SERVICE	44.27%
1P31791	SOUTH SIDE STATE INSPECTION	42.95%
4P37645	K R INSPECTIONS	41.83%
1P25236	AMERICAS BEST	38.20%
1P36591	METRO CHAMPION AUTO REPAIR	37.56%
1P02156	FRIENDLY CHEVROLET CO INC	36.92%
2P26686	HI TEC AUTOMITVE	36.30%

Table 5-2. Stations with High Readiness Trigger Values

Station ID	Station	2 yr avg Ready Trigger
1P35817	INTERNATIONS AUTO SALES	88.86%
1P37284	SAN LUIS STATE INSPECTION	81.12%
1P37977	L E P STATE INSPECTIONS	80.30%
1P26066	J AND L AUTO REPAIR	78.48%
1P37139	JAY 2 INSPECTIONS	76.99%
1P32363	GUZMAN MOTORS & TIRES	75.82%
1P36986	SURFIN & RODS GARAGE	74.72%
1P36419	IMPERIAL INSPECTIONS	74.34%
1P37811	FTW STATE INSPECTIONS	74.20%
1P38012	ESR AUTOMATION	73.80%
1P37415	SCORPION TIRES LLC	73.16%
1P32898	VARGAS INSPECTION	71.98%
1P36208	MOCKINGBIRD STATE INSPECTION & REP	70.49%
1P35785	DLM	69.21%
2P34821	ABC BODY & PAINT	68.73%
1P32287	THREE RICHARDS INC	67.86%
1P37411	R & M AUTO CENTER	67.82%
1P36597	JESUCHISTRO TIRE SHOP	67.57%
1P37988	GERS 4	67.34%
1P37006	JEFFERSON STATE INSPECTION	66.40%
1P31719	COWBOY TIRE SERVICE	65.44%
1P33344	MARTINEZ AUTO DETAIL & STATE INSPE	62.93%
1P37940	JV TIRE SHOP SERVICE	61.58%
1P37893	QUICK CASH STATE INSPECTIONS	61.21%
2P30412	AL HODA CAR CARE	61.10%
2P31289	MUFFLER DEPOT	59.88%
1P36809	MIKES AUTO CARE	57.69%
1P37432	CITY PRE OWNED	57.68%
1P37631	THE WARRIOR SHOP	57.49%
1P37231	SERGIOS ALIGNMENT	57.45%
1P36998	GERS BRAKE SERVICE #3	57.21%
1P36321	A-1 AFFORDABLE MOTORS INC	56.88%
1P32910	ROMEOS TRANSMISSIONS	55.74%
1P37414	JC`S AUTOMOTIVE CENTER	55.25%
1P37104	LCA AUTOMOTIVE & INSPECTION	55.09%
1P28329	BIG D TIRES & INSPECTION	54.45%
1P37724	EQUIA AUTOMOTIVE REPAIR	54.18%
2P36714	STELLA LINK AUTO CARE	53.86%
1P36073	RICO GARAGE	53.62%
1P34167	EXCEL AUTO CENTER	53.56%
1P36937	GERS BRAKE SERVICE #2	52.65%
4P33836	HORIZON AUTO SERVICE	50.44%
4P33140	EL PASO COLLISION CENTER	50.14%
1P37584	HAROLD DISCOUNT TIRE SERVICE	50.13%
1P33861	LINDAS STATE INSPECTION #2	49.60%
2P36491	JS MOTOR	49.51%
1P37289	MGN AUTOMOTIVE	49.16%
2P36381	ABADAN AUTO SERVICE	48.69%
1P36641	GREGS INSPECTIONS	48.57%
1P35854	LANCE AUTO REPAIR	48.48%

Table 5-2. Continued

Station ID	Station	2 yr avg Ready Trigger
1P18012	FERS ALIGNMENT BRAKES & MUFFLERS	46.82%
1P37775	REYES MUFFLER	46.80%
4P32677	C & E AUTO SERVICE	46.75%
1P36306	DISCOUNT TURBO TIRE & INPSPECTIONS	44.73%
1P33865	RODRIGUEZ TIRE SERVICE #2	44.72%
1P33936	3 ACES AUTO SALES	44.66%
4P28631	NATIONS AUTO CENTER	43.29%
4P28171	L A AUTO CLINIC	43.05%
1P33795	COVARRUBIAS CAR SERVICE	43.04%
1P36692	KELS AUTOMOTIVE	42.84%
1P35540	U S DISCOUNT TIRES & CAR SERVICE	42.53%
1P37855	ANY CARS	42.05%
1P35608	BELKNAP AUTO	42.04%
1P37198	MASTER AC STATE INSPECTION	41.77%
1P27629	RODRIGUEZ TIRE SERVICE	41.59%
2P30537	HW 59 PHILLIP 66	41.48%
2P30969	AUTO BELL	41.08%
1P37589	ALVAREZ TIRE SHOP	40.39%
2P36754	AMA AUTOMOTIVE	40.01%
1P32654	CRUZIN STATE INSPECTION	39.75%
1P35016	GERS BRAKE SERVICE	39.37%
1P32390	EMISSIONS & TRANSMISSIONS	38.59%
1P27065	DON PACOS GARAGE	37.49%
2P35794	HI TECH AUTO DIAGNOSTIC INC	37.11%
1P35091	LINDAS STATE INSPECTIONS #3	36.37%
2P34869	PASADENA AUTO COLLISION CENTER INC	35.65%
1P35882	DISCOUNT AUTO SERVICE	35.45%
1P36058	BESTWAY INSPECTIONS	35.19%
1P37182	YOSIAS AUTO SERVICE & REPAIRS	34.63%
1P35692	ROMEROS STATE INSPECTION	33.99%

Table 5-3. Stations with High 96tp Trigger Values

Station ID	Station	> 5 tests/day	~ 5 tests/day	< 1 test/day
1P34970	AMERICAR STATE INSPECTION	77.36%		
1P33144	VALENZUELA INSPECTIONS	55.94%		
2P32413	JOSES AUTO SALE	54.12%		
1P32378	CENTER AUTO SALES LLC	50.52%		
1P32203	IRVING WRECKER SERVICE	46.07%		
2P35801	JOSES AUTO SALE # 2	46.06%		
2P27451	EXPRESS CARE	43.03%		
1P37005	2222 STATE INSPECTION	41.07%		
2P33665	EXPRESS CARE	36.76%		
1P00576	NAGYS DIAMOND	36.56%		
1P32390	EMISSIONS & TRANSMISSIONS	36.07%		
1P36442	C & A INSPECTION AND DETAIL	33.55%		
2P37313	C & H INSPECTIONS	32.89%		
1P36663	MARIAS INSPECTION	32.00%		
2P32598	FULTON TIRES	31.36%		
1P37285	MILLENNIUM DRIVE THRU	31.30%		
2P02227	MC DONALDS GARAGE	29.27%		
1P37811	FTW STATE INSPECTIONS	28.93%		
2P27382	EXPRESS CARE	27.26%		
1P28329	BIG D TIRES & INSPECTION	26.78%		
1P00621	FLORES AUTOMOTIVE	26.73%		
2P36090	HOUSTON`S BEST SERVICE CENTER	26.36%		
1P25185	CEDAR AUTO SALES	25.91%		
1P28662	J-L AUTO REPAIR	25.74%		
1P36834	PARRA MOTORS	25.42%		
1P30986	SERRATOS STATE INSPECTION	25.28%		
2P35716	QUIK INSPECTIONS #3	24.67%		
2P33970	JOES STATE INSPECTION	24.66%		
1P33574	DSD	24.57%		
1P37401	RUDYS AUTO INVESTMENTS	22.61%		
1P36324	PARK CITIES INSP	22.33%		
1P37536	TONYS FINA	21.70%		
1P36900	MILLENIUM AUTO REPAIR & STATE INSP		64.70%	
1P36785	CANDELAS INSPECTIONS		62.42%	
1P37961	BENCO AUTO SVC		51.99%	
1P31962	15 MINUTES STATE INSPECTION		48.06%	
2P12089	WAYSIDE INC		40.77%	
2P36745	R AND R AUTO REPAIR		39.77%	
2P37709	JUAN`S AUTO SALES		37.89%	
1P34349	EAST COAST MOTOR SPORTS		37.23%	
1P25147	SOLIS AUTO REPAIR #2		36.67%	
1P37837	E Z AUTO STATE INSPECTION		34.10%	
2P37256	AJG TRANSMISSION		32.45%	
2P36492	JESSES COMPLETE AUTO SERVICE		32.28%	
2P36761	GALINDOS AUTO DIESEL + MARINE REP		30.97%	
2P35133	NETWORK AUTO CREDIT		29.79%	
2P37663	EASTEX INSPECTIONS		27.12%	
1P37621	UNICO AUTOMOTIVE INC		25.59%	
2P11246	SOUTHBELT AUTOMOTIVE CENTER		24.97%	
1P32646	DS AUTO PARTS		24.29%	
1P31752	MILTONS LAKESIDE STATE INSPECTION		21.37%	
1P37809	HORN AUTO		21.23%	
1P26734	CAR CLINIC CENTER		20.08%	
2P37278	COASTAL BAY INSPECTIONS			28.60%

Table 5-4. Stations with High Emission Fail Rate Trigger Values

Station ID	Station Name	> 5 tests/day	~ 5 tests/day	< 1 test/day
2P32154	LANGS MASTER CAR CARE #1 INC	26.05%		
1G25792	TEXAS DEPARTMENT OF PUBLIC SAFETY		67.95%	
1P25236	AMERICAS BEST		25.67%	
1P36133	GARLAND RADIATOR		22.18%	
6P32918	TOKYO AUTOS		21.58%	
1G34843	TEXAS DEPARTMENT OF PUBLIC SAFETY			86.51%
2G34721	TEXAS DEPARTMENT OF PUBLIC SAFETY			84.93%
6G36011	DPS WAIVER BAY			81.86%
2G25739	TEXAS DEPARTMENT OF PUBLIC SAFETY			77.90%
2P37515	KAR KARE AUTO CENTER			21.99%

Table 5-5. Stations with Low Emission Fail Rate Trigger Values

Station ID	Station Name	> 5 tests/day	~ 5 tests/day	< 1 test/day
1P37724	EQUIA AUTOMOTIVE REPAIR	0.21%		
2P31289	MUFFLER DEPOT	0.21%		
1P35817	INTERNATIONS AUTO SALES	0.43%		
2P36381	ABADAN AUTO SERVICE	0.44%		
1P33936	3 ACES AUTO SALES	0.44%		
1P37411	R & M AUTO CENTER	0.47%		
1P32925	TWO BROTHERS STATE INSPECTION	0.51%		
1P32898	VARGAS INSPECTION	0.52%		
1P34970	AMERICAR STATE INSPECTION	0.60%		
1P36809	MIKES AUTO CARE	0.62%		
1P37893	QUICK CASH STATE INSPECTIONS	0.63%		
1P37284	SAN LUIS STATE INSPECTION	0.70%		
2P37514	BERRY INSPECTIONS	0.70%		
1P37006	JEFFERSON STATE INSPECTION	0.71%		
1P27736	LINDAS STATE INSPECTION	0.76%		
1P37631	THE WARRIOR SHOP	0.81%		
1P00621	FLORES AUTOMOTIVE	0.81%		
1P35091	LINDAS STATE INSPECTIONS #3	0.86%		
1P33865	RODRIGUEZ TIRE SERVICE #2	0.92%		
1P37414	JC`S AUTOMOTIVE CENTER	0.96%		
1P27065	DON PACOS GARAGE	0.96%		
4P14328	GS AUTOMOTIVE	0.98%		
2P32041	SAM HOSS AUTO CENTER	0.99%		
1P32363	GUZMAN MOTORS & TIRES	1.03%		
1P36986	SURFIN & RODS GARAGE	1.03%		
2P30412	AL HODA CAR CARE	1.04%		
2P36738	MEDAS AUTO SERVICE CENTER	1.09%		
1P30947	TIRE AUTO STATION	1.11%		
1P35016	GERS BRAKE SERVICE	1.17%		
1P33795	COVARRUBIAS CAR SERVICE	1.19%		
1P37589	ALVAREZ TIRE SHOP	1.20%		
2P37663	EASTEX INSPECTIONS	1.22%		
6P37467	CLASSIC TOYOTA DBA ROUND ROCK TOYO	1.22%		
1P27003	CARMAX AUTO SUPERSTORES	1.23%		
1P36058	BESTWAY INSPECTIONS	1.23%		
1P36597	JESUCHISTRO TIRE SHOP	1.23%		
1P37886	REYES AUTO REPAIR	1.24%		
2P27129	CARMAX AUTO SUPERSTORES	1.25%		
2P35912	ANTHONYS AUTO SALES	1.26%		
2P34821	ABC BODY & PAINT	1.29%		
1P37415	SCORPION TIRES LLC	1.30%		
2P29938	MIDAS AUTO SERVICE	1.31%		
2P34220	HADJI M SHENI DBA GULF COAST FINAN	1.32%		
1P25121	WESTCLIFF TEXACO	1.39%		
1P36785	CANDELAS INSPECTIONS	1.40%		
1P28504	MCKINNEY OIL X-CHANGE	1.45%		
1P36998	GERS BRAKE SERVICE #3	1.45%		
2P32313	B & B AUTO GLASS & REPAIR	1.45%		
1P32654	CRUZIN STATE INSPECTION	1.46%		
2P28113	NORTHSIDE LEXUS	1.47%		
1P31962	15 MINUTES STATE INSPECTION	1.52%		
2P19567	WOODLANDS TEXACO XPRESS LUBE	1.55%		
1P35319	DEL RIO INSPECTIONS	1.57%		

Table 5-5. Continued

Station ID	Station Name	> 5 tests/day	~ 5 tests/day	< 1 test/day
2P07688	STERLING MC CALL LEXUS	1.63%		
1P33861	LINDAS STATE INSPECTION #2	1.75%		
1P36900	MILLENIUM AUTO REPAIR & STATE INSP	1.76%		
2P29625	COMPLETE CAR CARE	1.81%		
2P33282	CLEAR LAKE VOLKSWAGEN		0.11%	
1P38012	ESR AUTOMATION		0.29%	
1P35854	LANCE AUTO REPAIR		0.49%	
1P37432	CITY PRE OWNED		0.49%	
1P36676	PARS AUTOMOTIVE LLC		0.54%	
2P03622	BENNYS AUTO REPAIR		0.55%	
2P29466	PEAVYS GARAGE		0.61%	
1P37422	DUHA GARAGE		0.72%	
6P10702	FORREST PONTIAC BUICK GMC TRUCK		0.79%	
1P31005	ARLINGTON ROYAL AUTO SERVICE INC		0.89%	
1P32098	GOODYEAR #4181		0.89%	
1P32198	SHELL RAPID LUBE		0.93%	
1P02964	DAVIDSON CAR CARE		0.95%	
5P22602	ROGER WILLIAMS CHRYSLER DODGE JEEP		1.02%	
1P07571	DON HERRING MITSUBISHI		1.06%	
2P29620	CHAMPION AUTOMOTIVE		1.15%	
1P35099	SATURN OF ARLINGTON		1.16%	
2P02383	GILLMAN ACURA		1.17%	
1P31512	SATURN OF PLANO		1.17%	
2P04030	SHARPSTOWN AUTOMOTIVE		1.18%	
1P37421	DUHA GARAGE		1.21%	
1P33632	VINTAGE CAR WASH DETAIL AND LUBE		1.23%	
1P32066	TRINITY CAR CARE		1.26%	
2P09450	SUPERIOR LINCOLN MERCURY		1.26%	
4G20050	CITY OF EL PASO MUNICIPAL SVC CTR		1.26%	
2P37512	HOOKS ROYAL INVESTMENTS		1.33%	
2P12809	STREATER SMITH HONDA		1.37%	
2G20746	CITY OF HOUSTON POLICE DEPT		1.37%	
2P33704	RICHMOND TIRE & AUTOMOTIVE		1.37%	
1P04198	HUGGINS HONDA		1.38%	
2P30858	AUTO CHECK # 19		1.40%	
2P37499	BC AUTO		1.41%	
2P05003	STAR TOYOTA		1.51%	
1P37855	ANY CARS		1.52%	
1P34167	EXCEL AUTO CENTER		1.53%	
1P34102	KWIK KAR LUBE &TUNE		1.53%	
1P08036	METROPLEX TOYOTA		1.54%	
2F21194	GREATER HOUSTON TRANSPORTATION CO		1.57%	
2P28713	NOAHS SERVICE CENTER		1.63%	
2P10393	GREGS GREASE RACK INC		1.65%	
2P12375	GULLO TOYOTA		1.66%	
2P01238	GENE HAMON FORD INC		1.73%	
6F31011	CASA MECHANICAL SERVICES			0.00%
2P35794	HI TECH AUTO DIAGNOSTIC INC			0.47%
2G20577	MONTGOMERY COUNTY SHERIFF OFFICE			0.67%
1F21477	VERIZON SOUTHWEST			1.36%
2G20948	FEDERAL BUREAU OF INVESTIGATION			1.37%

Using the results in Tables 5-1 through 5-5 as a starting point, a new table of data was created that contained an entry for each station, and then the trigger result for each of the four respective triggers. The intent is to identify those stations that are exhibiting suspiciously high values for more than one trigger. Tables 5-6a and 5-7a list those stations that had more than one of the four triggers flagged.

The eVIN and readiness trigger data were also analyzed in more detail to determine if more specific information could be gleaned using the on-line triggers tool that may be of use for enforcement purposes. The data appearing in Tables 5-8a through 5-11a were obtained by selecting either the eVIN or Ready trigger, and then selecting 2009 Report Period, All I/M Counties, All MY, Decile 9. Then in the next screen in the Trigger IQ column, the Details link is clicked and the Station Info, Vehicle Info, General Test Info and OBD Test Info are selected. The resulting screen highlights the eVIN mismatches and double-clicking on an eVIN yields a screen with the vehicle owner information. This same procedure was followed to obtain Decile 8 station information for the eVIN trigger, and then the process was repeated for the Ready trigger. Note that all the data appearing in Tables 5-8a through 5-11a are for Deciles 8 and 9, so the stations and inspectors identified here should be considered as those most likely to be performing fraudulent OBD tests based on the triggers data.

What is apparent from Table 5-8a is that the same VIN is being used multiple times in what is likely an attempt to clean-scan a vehicle. As mentioned earlier, pre-MY05 vehicles may not provide accurate eVIN values; however, the data in Table 5-9a, which is a detailed look at the eVIN mismatches for Inspector 8950606 at Guzman Motors & Tires in Table 5-8a, indicates that eVIN trigger is flagging apparent attempts at clean-scanning. A table including MY for each inspector like Table 5-9a is too cumbersome to include in this text, but can easily be manipulated in Excel. The analysis done on this data indicate that eVIN clean-scanning is not as prevalent as it appears on 2004 and older vehicles where the e-VIN is less reliable, indicating the adaptation of CAN in all models has made analysis of the e-VIN in comparison w/ the test record VIN a more reliable indicator of fraud.

Trigger data for the Ready metric were obtained in a similar fashion and the results are presented in Tables 5-10a and 5-11a below. Table 5-10a indicates which inspectors at which stations are performing OBD tests with high numbers of supported monitor profile mismatches. Again, it is clear that this data warrants some type of enforcement follow-up to determine the cause for such high numbers of mismatches for these inspectors.

Table 5-6a. Stations with Three Triggers Flagged

(tpd is "tests per day")

Station	Station ID	eVIN	Rdy	96tp (> 5 tpd)	96tp (~ 5 tpd)	96tp (< 5 tpd)	Emissions (> 5 tpd)	Emissions (~ 5 tpd)	Emissions (< 5 tpd)
JESUCHISTRO TIRE SHOP	1P36597	99.52%	67.57%				1.23%		
CITY PRE OWNED	1P37432	99.47%	57.68%					0.49%	
EXCEL AUTO CENTER	1P34167	92.74%	53.56%					1.53%	
GUZMAN MOTORS & TIRES	1P32363	67.68%	75.82%				1.03%		
LINDAS STATE INSPECTION #2	1P33861	83.47%	49.60%				1.75%		
JC`S AUTOMOTIVE CENTER	1P37414	75.86%	55.25%				0.96%		
LANCE AUTO REPAIR	1P35854	77.06%	48.48%					0.49%	
GERS BRAKE SERVICE #3	1P36998	66.17%	57.21%				1.45%		
LINDAS STATE INSPECTIONS #3	1P35091	66.55%	36.37%				0.86%		

Table 5-7a. Stations with Two Triggers Flagged

Station	Station ID	eVIN	Rdy	96tp (> 5 tpd)	96tp (~ 5 tpd)	96tp (< 5 tpd)	Emissions (> 5 tpd)	Emissions (~ 5 tpd)	Emissions (< 5 tpd)
MOCKINGBIRD STATE INSPECTION & REP	1P36208	86.08%	70.49%						
SERGIOS ALIGNMENT	1P37231	90.98%	57.45%						
JS MOTOR	2P36491	92.10%	49.51%						
MARTINEZ AUTO DETAIL & STATE INSPE	1P33344	70.69%	62.93%						
EL PASO COLLISION CENTER	4P33140	81.43%	50.14%						
C & E AUTO SERVICE	4P32677	81.88%	46.75%						
KELS AUTOMOTIVE	1P36692	83.70%	42.84%						
FERS ALIGNMENT BRAKES & MUFFLERS	1P18012	75.93%	46.82%						
GREGS INSPECTIONS	1P36641	66.65%	48.57%						
L A AUTO CLINIC	4P28171	68.56%	43.05%						
FTW STATE INSPECTIONS	1P37811		74.20%	28.93%					
PASADENA AUTO COLLISION CENTER INC	2P34869	64.03%	35.65%						
INTERNATIONS AUTO SALES	1P35817		88.86%				0.43%		
SAN LUIS STATE INSPECTION	1P37284		81.12%				0.70%		
BIG D TIRES & INSPECTION	1P28329		54.45%	26.78%					
YOSIAS AUTO SERVICE & REPAIRS	1P37182	45.78%	34.63%						
AMERICAR STATE INSPECTION	1P34970			77.36%			0.60%		
LINDAS STATE INSPECTION	1P27736	77.05%					0.76%		
SURFIN & RODS GARAGE	1P36986		74.72%				1.03%		
EMISSIONS & TRANSMISSIONS	1P32390		38.59%	36.07%					
SCORPION TIRES LLC	1P37415		73.16%				1.30%		
ESR AUTOMATION	1P38012		73.80%					0.29%	
VARGAS INSPECTION	1P32898		71.98%				0.52%		
ABC BODY & PAINT	2P34821		68.73%				1.29%		
R & M AUTO CENTER	1P37411		67.82%				0.47%		
JEFFERSON STATE INSPECTION	1P37006		66.40%				0.71%		
MILLENIUM AUTO REPAIR & STATE INSP	1P36900				64.70%		1.76%		
AMERICAS BEST	1P25236	38.20%						25.67%	
CANDELAS INSPECTIONS	1P36785				62.42%		1.40%		
AL HODA CAR CARE	2P30412		61.10%				1.04%		
QUICK CASH STATE INSPECTIONS	1P37893		61.21%				0.63%		
MUFFLER DEPOT	2P31289		59.88%				0.21%		
MIKES AUTO CARE	1P36809		57.69%				0.62%		
THE WARRIOR SHOP	1P37631		57.49%				0.81%		

Table 5-7a. Continued

Station	Station ID	eVIN	Rdy	96tp (> 5 tpd)	96tp (~ 5 tpd)	96tp (< 5 tpd)	Emissions (> 5 tpd)	Emissions (~ 5 tpd)	Emissions (< 5 tpd)
EQUIA AUTOMOTIVE REPAIR	1P37724		54.18%				0.21%		
15 MINUTES STATE INSPECTION	1P31962				48.06%		1.52%		
ABADAN AUTO SERVICE	2P36381		48.69%				0.44%		
RODRIGUEZ TIRE SERVICE #2	1P33865		44.72%				0.92%		
DUHA GARAGE	1P37422	44.91%						0.72%	
3 ACES AUTO SALES	1P33936		44.66%				0.44%		
COVARRUBIAS CAR SERVICE	1P33795		43.04%				1.19%		
ANY CARS	1P37855		42.05%					1.52%	
ALVAREZ TIRE SHOP	1P37589		40.39%				1.20%		
CRUZIN STATE INSPECTION	1P32654		39.75%				1.46%		
GERS BRAKE SERVICE	1P35016		39.37%				1.17%		
DON PACOS GARAGE	1P27065		37.49%				0.96%		
HI TECH AUTO DIAGNOSTIC INC	2P35794		37.11%						0.47%
BESTWAY INSPECTIONS	1P36058		35.19%				1.23%		
EASTEX INSPECTIONS	2P37663				27.12%		1.22%		
FLORES AUTOMOTIVE	1P00621			26.73%			0.81%		

Table 5-8a. eVIN Trigger Mismatches by Inspector

Station	Insp. ID	VIN	Match	Mismatch	Grand Total
GUZMAN MOTORS & TIRES	8950606	JH4CL96876C009239	1		1
		2FMZA52471BB57800		27	27
	19792911	2FMZA52471BB57800		75	75
		1N6AA07A35N504453	1		1
		1GYEK63N34R126827	1		1
		1FMYU04101KF85481	1		1
		1FMRU15W33LB43151	1		1
	23605999	5TDZA22C45S221595	1		1
		3GYEK63N23G192185	1	1	2
		2G1WW12E459255389		1	1
		2FMZA52471BB57800		82	82
		1GCDT13W42K121247	1		1
		1FTRX17W0YKB40178	1		1
		1FTRW07652KE34471	1		1
LANCE AUTO REPAIR	8421903	WBAWC335X8PD09195	1	4	5
		JTJBT20X360102214		2	2
		JHMGD386X7S023117		4	4
		5TFEV54138X052300		5	5
		5TDZA23C46S388605		8	8
		4T1BE46K59U868281		1	1
		2T2GK31U57C026066	1		1
		1NXBR32E47Z864539		3	3
		1NXBR32E46Z755626		3	3
		1HGFA16537L110812		3	3
	15979718	WAULC68E45A049076	1		1
		JN8AZ08W15W410107	1		1
		4T1BE46K07U662816	1		1
		2GCEK19N231290075	1		1
		1J4HS58N86C337043	1		1
LYNN STATE INSPECTIONS	12307534	2G4WS52J331219143		65	65
		1GNDS13S862217671	1		1
	22887656	1GKEC13Z83R291381	1		1
		1FAFP383XYW259986	1		1
PETERS AUTO SALES	12067177	4T1FA38P35U039865	1		1
		4F2YU09102KM38382		13	13
		2G1WT55K479128341	1		1
		1N6AD07U16C467952	1		1
		1FTRW07W71KB17158	1	18	19
		1FMRU17W31LB18504	1		1
SERGIOS ALIGNMENT	3609680	KMHDN46D96U322508	1		1
		1GNEC13T41R204751	1		1
		1G8JU54F02Y547076		34	34
	16670787	1HGEM225X5L068604		1	1
		1GNES16S436111951	1		1
		1GNDS13S722489994	1		1
		1GKEC16Z62J132044	1		1
		1G8JU54F02Y547076		5	5
		1G1ZT51F26F141584	1		1
		1G1JC52F037119293	1		1

Table 5-8a. Continued

Station	Insp. ID	VIN	Match	Mismatch	Grand Total
TEX MEX MOTOR CO	21378920	JM1BK12F941167239	1		1
		5TETU62N05Z075396	1		1
		5TBET34136S539731		1	1
		5LMFU28556LJ18846	1		1
		5LMFU27R63LJ25787	1	1	2
		5LMFU27567LJ18549	1		1
		3TMJU62N45M004643	1	150	151
		3GCEC14X56G162205		3	3
		3G5DA03E03S519334	1		1
		2GCEC13VX61192860	1		1
		2G1WF55KX39426748	1		1
		2FMZA57694BA84699	1	1	2
		2C4GP54L24R562263	1	8	9
		2C3KA53G66H312845	1	1	2
		1ZVHT80N895100669		1	1
		1NXBR32E96Z666103	1		1
		1N4AL21EX7C179261	1		1
		1HGCM72336A016313		2	2
		1GTEC14V02Z154909	1	1	2
		1GNFK16Z13R246899	1		1
		1GNEK13V34J157333	1	1	2
		1GNEK13T71J206897	1		1
		1GNEC16Z02J279351	1		1
		1GNEC13V32R167565	1		1
		1GNEC13V24R237740	1		1
		1GNEC13T91J121704	1		1
		1GNDS13S132190471	1	7	8
		1GKEC13Z72R228237	1		1
		1GKEC13T01J228928	1		1
		1GCHC29U94E265259	1		1
		1GCFG15X751163926	1		1
		1GCEC14X37Z613407		1	1
		1GCCS1456YK243749	1		1
		1G8ZH5282YZ212545	1		1
		1G6DM57N930118141	1	1	2
		1G3NL52T61C268651	1		1
		1G1ZS52F85F265360	1		1
		1G1ZS52F34F139549		1	1
		1G1JC52F247359107		1	1
		1G1AL52F857517676	1		1
		1FTRX17W73NA21387	1		1
		1FTRX17LXYKA19874		1	1
		1FTRX12W65FA98756	1		1
		1FTRX07283KB08286		1	1
		1FTRW14W08FB33103		1	1
		1FTRW12W58FB91615		2	2
		1FTRW12W15FB23498		1	1
		1FTRW12547FB42508	1		1
		1FTRW08L53KA17759		5	5
		1FTRW07L03KB27507	1		1
		1FTPW12V07FB16432	1		1
		1FTPW12504KC64020	1		1

Table 5-8a. Continued

Station	Insp. ID	VIN	Match	Mismatch	Grand Total
		1FTPW12504KB99962	1		1
		1FMZU63K35ZA55455		1	1
		1FMZU63K25UA75144	1	7	8
		1FMZU62K02ZC70692		4	4
		1FMYU03144KA51695	1	1	2
		1FMCU031X6KB18961	1		1
		1FAFP44444F118345	1		1
		1FAFP34P91W232812	1		1
		1FAFP34N86W221662		1	1
		1FAFP34N35W190562	1		1
		1D7HA18NX3S205748	1		1
		1D7HA18N56J107737		1	1
		1D7HA16D64J192501	1		1
		1D4HD48N44F138872		12	12
		1B3ES56C63D238478	1		1
		1B3ES26C83D226766	1		1
	29144156	5GRGN23U25H132517	1		1
		3TMJU62N45M004643		3	3
		1GNFK16Z13R246899		4	4
		1GCHK23U93F111980		2	2
		1G2NF52T1YC542442	1	1	2
		1FTRX17W5YNB89648	1		1
		1FTRX17W3YNA75843	1		1
		1FTRW08L53KA17759		1	1
		1FTRF122X5NB72301	1		1
		1FBSS31L78DA20347	1		1
		1D4HD48N44F138872	1	6	7
		1B3ES56C55D163436		1	1

Table 5-9a. eVIN Trigger Mismatches by MY for One Inspector

Station	Insp. ID	MY	VIN	Match	Mismatch	Grand Total
GUZMAN MOTORS & TIRES	8950606	1996	2FMZA52471BB57800		2	2
		1997	2FMZA52471BB57800		2	2
		1999	2FMZA52471BB57800		4	4
		2000	2FMZA52471BB57800		5	5
		2001	2FMZA52471BB57800		2	2
		2002	2FMZA52471BB57800		5	5
		2003	2FMZA52471BB57800		5	5
		2004	2FMZA52471BB57800		2	2
		2006	JH4CL96876C009239	1		1

Table 5-10a. Ready Trigger Mismatches by Inspector

Station	Insp. ID	Match	Mismatch	Grand Total
3 AMIGOS CAR INSPECTIONS	2047830	15	127	142
A N V AUTO CAR AND TIRE C	19792911	12	48	60
ANC INSPECTIONS	9460922	96	361	457
	17303349	17	132	149
	23325602		3	3
	26813357	5	14	19
B 5 TIRE SERVICE	24776260	2	20	22
BIG D TIRES & INSPECTION	6883517	178	682	860
C AND L STATE INSPECTIONS	2783184	18	269	287
	15691303	1	28	29
	16670787	5		5
	17164445	15	162	177
	24230625	13	114	127
	28207476	28	101	129
DIXON LANE INSPECTIONS	10249501	93	500	593
	17303349	3	12	15
	26562507	158	452	610
	28983626	1	11	12
DLM	9806592	218	1,186	1,404
	12505728	5	34	39
	12516577	11	64	75
	24016476	74	715	789
GERS BRAKE SERVICE #2	1841166	49	732	781
IMPERIAL INSPECTIONS	24901515	363	1,542	1,905
	Y 24901	1	1	2
INTERNATIONS AUTO SALES	20508515	3	55	58
	21205122	8	60	68
	25325248	9		9
J & B INSPECTIONS	9460922	3	3	6
	25235870	102	591	693
	28983626	8	119	127
JACKS BRAKES AND MUFFLERS	7855211	50	189	239
	12063192	2	3	5
	15691303	86	218	304
	20919816	8	81	89
	29294119	6	39	45
JAY 2 INSPECTIONS	2420984	5	129	134
	6842442	9	21	30
	16849873	72	195	267
	17212664	3		3
JMP AUTOBODY REPAIR	23891318	71	276	347
JV TIRE SHOP SERVICE	24776260	49	323	372
MURDOCK STATE INSPECTIONS	3158886	1	91	92
	33120186	7	113	120
PARS AUTO INSPECTION	25259500	6	29	35
S.C SHOP	7855211	125	639	764

Table 5-10a. Continued

Station	Insp. ID	Match	Mismatch	Grand Total
	12063192	157	759	916
	15691303	15	105	120
	20919816	1	22	23
	24230625	3	26	29
SAN LUIS STATE INSPECTION	15405400	22	151	173
	24262728	20		20
	26562507	9	1	10
	27418587	33	184	217

The data in Table 5-11a breaks out additional detail by providing the VIN for the data in Table 5-10a for the first 4 stations; however, this detail is not as informative as it was for the eVIN trigger. This is because the mismatch being flagged here is for the monitor support profile, not the VIN, so the relationship is not as direct. Also, in many cases, the VIN value was blank. Regardless, of these limitations, the data in Table 5-10a clearly indicate that as was the case with the eVIN trigger, there is sufficient data here to warrant following-up with an enforcement inquiry for these stations to better understand how such high numbers of supported monitor profile mismatches can be occurring.

Table 5-11a. Ready Trigger Mismatches by Inspector with VIN

Station	Insp. ID	VIN	Match	Mismatch	Grand Total
3 AMIGOS CAR INSPECTIONS	2047830		15	127	142
A N V AUTO CAR AND TIRE C	19792911		12	48	60
ANC INSPECTIONS	9460922		83	354	437
		1FAFP3432YW273354	8	6	14
		1FTR1FTR1FTR1FTR1	1		1
		1GCEC14V34Z184456	1		1
		1GNEC13T31J116787		1	1
		2FTRX17W93CA95982	1		1
		2GCEC19VX21175736	1		1
		2GCEK13T441382362	1		1
	17303349		12	126	138
		1FAFP3432YW273354	3	2	5
		1GCCS1457YK284858	2	4	6
	23325602			3	3
	26813357		4	14	18
		1G1ND52F84M587306	1		1
B 5 TIRE SERVICE	24776260		2	20	22

5.2 Use of TIMS Data to Detect Non-Compliance with OBD Inspection Procedures

In this subsection, we will cover several methods for using TIMS data to check the accuracy of Texas' OBD inspection records.

5.2.1 OBD Inspection Analyzer Communication Performance

ERG analyzed 2007 and 2008 TIMS OBD data to look for proper scanner communication as it is possible that certain models of scanners communicate improperly with certain model year, make, and model vehicles. The objective of this task was to analyze TIMS data to determine if certain models of OBD inspection analyzers appear to have communication problems with certain makes, models, or model year vehicles, which would result in higher or lower fail rates than appropriate for those vehicle categories.

For this task, ERG reviewed OBD inspection records to identify all tests with an "N" (no communication/signal) in the "OBD2_DLC_RES" field of the test record. For these records, analysis was performed to identify the following:

- Rate of failure to communicate by analyzer manufacturer
- Rate of failure to communicate by vehicle make
- Rate of failure to communicate by vehicle model
- Rate of failure to communicate by vehicle model year

Results are presented for these four categories below.

73,655 of the 13,614,382 OBD test records had no information stored in the OBD communication result field. All these records had null values for ready result, fault code result, downloaded MIL status, and OBD pass/fail results. 26 OBD test records had vehicle model years earlier than 1996 or later than 2009. 526,788 records were for heavy-duty (HD) vehicles or vehicles of unknown GVWR. All of these records were excluded from the following results, leaving 13,013,913 OBD records in the dataset.

Communication Rates by Vehicle Model Year - Table 5-6 provides a summary of communication rates by model year of vehicles tested in the program. The "MODEL_YEAR" field from the vehicle test result tables was used to determine model year. From this table, it can be seen that 13,013,893 OBD tests had some type of result in the OBD communication result (OBD2_DLC_RES) field. Values and percentages shown in the table are listed by model year (MY). For example, 810,901 OBD tests were conducted on model year 1997 vehicles, and 519 of these (0.06% of all MY 1997 vehicle OBD tests) had an OBD fail to communicate status. Overall, very low numbers were seen for "failure to communicate" test results, and the overall "failure to communicate" rates were well under 0.1%. Model year 1996 and 1997 vehicles had slightly higher "fail to communicate" rates than did later model years. This is expected, as 1996 was the first model year for mandatory full implementation of OBDII. The overall program-wide communication rate between vehicles and analyzers is 99.9%.

Table 5-6. OBD Communication Rates by Vehicle Model Year

Model Year	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model yr
	Count	Percent	Count	Percent	Count	Percent	
1996	851	0.14	458	0.07	618,569	99.79	619,878
1997	758	0.09	519	0.06	809,624	99.84	810,901
1998	635	0.07	464	0.05	940,752	99.88	941,851
1999	908	0.08	588	0.05	1,111,211	99.87	1,112,707
2000	1,063	0.08	711	0.05	1,292,987	99.86	1,294,761
2001	969	0.07	666	0.05	1,365,180	99.88	1,366,815
2002	718	0.05	467	0.03	1,445,728	99.92	1,446,913
2003	723	0.05	464	0.03	1,399,038	99.92	1,400,225
2004	934	0.07	603	0.04	1,400,423	99.89	1,401,960
2005	953	0.07	708	0.05	1,358,327	99.88	1,359,988
2006	506	0.06	422	0.05	877,103	99.89	878,031
2007	137	0.04	155	0.04	351,760	99.92	352,052
2008	5	0.02	12	0.05	26,207	99.94	26,224
2009	1	0.06	1	0.06	1,585	99.87	1,587
Total	9,161	0.07	6,238	0.05	12,998,494	99.88	13,013,893

Communication Rates by Equipment Manufacturer - Table 5-7 provides results of communication rates among the various analyzer manufacturers, Environmental Systems Products (ES), Sun (SE), John Bean (JB), and World Wide (WW). Again, the percentages shown for the "damaged, inaccessible or cannot be found," the "will not communicate" and the "successfully communicates" columns pertain to all tests conducted by each type of analyzer (not percentage of all tests). The final right two columns provide counts of tests and percentages of tests by each analyzer manufacturer relative to the total number of tests.

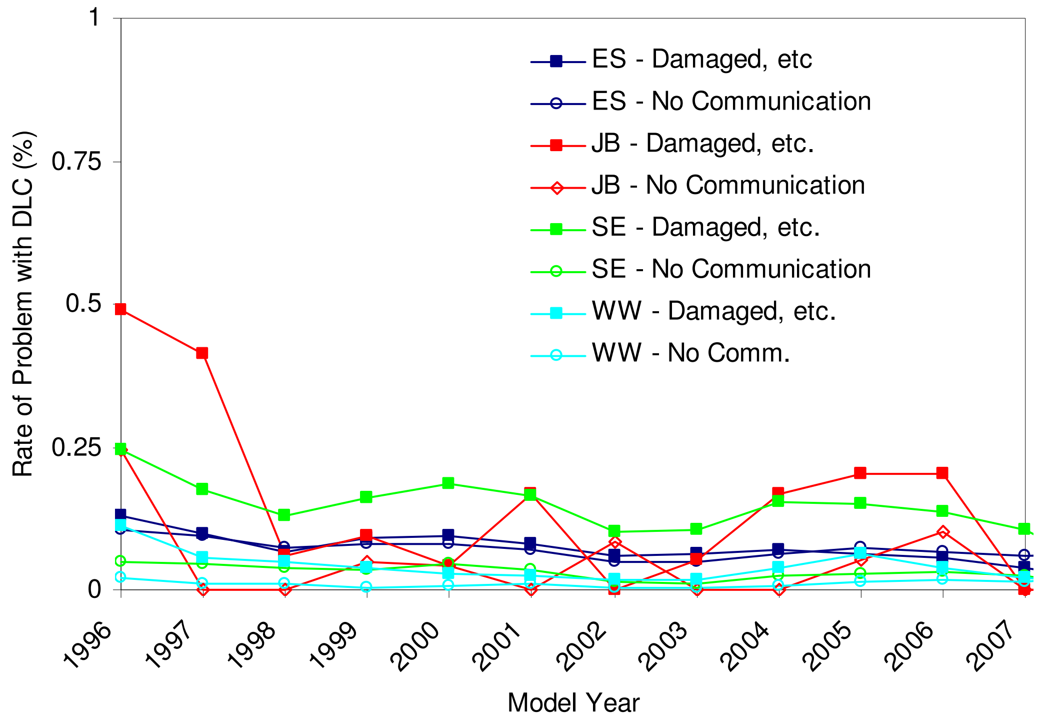
Table 5-7. OBD Communication Rates by Equipment Manufacturer

Equipment Manufacturer (EM)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by EM	% of tests by EM
	Count	Percent	Count	Percent	Count	Percent		
ES	5,876	0.07	5,497	0.07	7,847,674	99.86	7,859,047	60.39
JB	30	0.14	9	0.04	20,679	99.81	20,718	0.16
SE	1,698	0.15	350	0.03	1,126,960	99.82	1,129,008	8.68
WW	1,557	0.04	382	0.01	4,003,181	99.95	4,005,120	30.78
Total	9,161	0.07	6,238	0.05	12,998,494	99.88	13,013,893	100.00

The rate at which communication problems were experienced is shown graphically by both analyzer manufacturer and model year, in Figure 5-1. This figure illustrates the trends in rates of problems with communication for analyzers of each manufacturer, over the range of model years that were tested in the data under analysis (inspections between 2007 and 2008).

For the most part, the rate of problems with communication was consistently low for each manufacturer.

Figure 5-1 Change in Rate of DLC Communication Problems over Model Year, by Analyzer Manufacturer



Communication Rates by Vehicle Make - To assess communication rates by vehicle make, vehicle registration records were merged with vehicle test records by VIN. The "VEHMK" field from the registration database was reviewed, but found to have numerous inconsistencies and errors. Similarly, the "MAKE" field from the vehicle test result table was evaluated and also found to have a number of inconsistencies. To obtain a consistent "make" list, VINs from the emission test records were decoded using the ERG VIN Decoder, and the "make" output from this decoding process was merged with the vehicle test records and used for this evaluation. A make from the VIN Decoder was unavailable for 146,924 records, so those records were excluded from this analysis. Makes that were represented by 100 or fewer vehicles were also removed from the table, since sample sizes would be too small to provide dependable results.

Table 5-8 provides a summary of communication rates among the various vehicle makes. Except for a small number of very uncommon vehicle makes (Ferrari, Rolls Royce) the incident rates for "damaged, inaccessible, or cannot be found" or "no communication" were very low.

Table 5-8. OBD Communication Rates by Vehicle Make

Vehicle Make	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by make	% of overall tests by make
	Count	Percent	Count	Percent	Count	Percent		
ACURA	72	0.05	41	0.03	152,260	99.93	152,373	1.18
ASTON MARTIN	2	0.40	2	0.40	500	99.21	504	0.00
AUDI	24	0.06	23	0.06	37,029	99.87	37,076	0.29
BENTLEY	2	0.19		0.00	1,054	99.81	1,056	0.01
BMW	125	0.06	88	0.04	208,806	99.90	209,019	1.62
BUICK	92	0.05	66	0.04	180,731	99.91	180,889	1.40
CADILLAC	155	0.08	160	0.09	184,507	99.83	184,822	1.43
CHEVROLET	1,964	0.09	1,204	0.06	2,069,154	99.85	2,072,322	16.06
CHRYSLER	144	0.05	112	0.04	286,937	99.91	287,193	2.23
DAEWOO	8	0.10	9	0.12	7,677	99.78	7,694	0.06
DODGE	528	0.06	361	0.04	829,908	99.89	830,797	6.45
FERRARI	7	0.80	2	0.23	862	98.97	871	0.01
FORD	2,517	0.11	1,521	0.06	2,356,544	99.83	2,360,582	18.32
FORD/MAZDA	14	0.05	19	0.06	30,313	99.89	30,346	0.24
GMC	381	0.10	219	0.06	364,835	99.84	365,435	2.84
HONDA	310	0.03	141	0.01	965,444	99.95	965,895	7.50
HYUNDAI	109	0.07	73	0.05	151,769	99.88	151,951	1.18
INFINITI	25	0.02	27	0.02	123,270	99.96	123,322	0.96
ISUZU	64	0.09	52	0.08	68,075	99.83	68,191	0.53
JAGUAR	19	0.04	14	0.03	45,753	99.93	45,786	0.36
JEEP	83	0.03	85	0.03	308,170	99.95	308,338	2.39
KIA	40	0.03	38	0.03	144,414	99.95	144,492	1.12
LAND ROVER	20	0.07	12	0.04	28,697	99.89	28,729	0.22
LEXUS	55	0.02	59	0.02	306,349	99.96	306,463	2.38
LINCOLN	209	0.14	128	0.08	150,791	99.78	151,128	1.17
LOTUS		0.00		0.00	472	100.00	472	0.00
MASERATI		0.00		0.00	684	100.00	684	0.01
MAZDA	244	0.11	227	0.10	230,871	99.80	231,342	1.80
MERCEDES	72	0.04	47	0.03	184,710	99.94	184,829	1.43
MERCURY	136	0.07	85	0.04	203,366	99.89	203,587	1.58
MITSUBISHI	187	0.09	174	0.08	208,639	99.83	209,000	1.62
NISSAN	289	0.04	285	0.04	719,279	99.92	719,853	5.59
OLDSMOBILE	54	0.06	27	0.03	92,719	99.91	92,800	0.72
PLYMOUTH	30	0.05	34	0.06	56,856	99.89	56,920	0.44
PONTIAC	223	0.08	132	0.05	280,138	99.87	280,493	2.18
PORSCHE	4	0.02	3	0.01	21,787	99.97	21,794	0.17
ROLLS ROYCE	1	0.27	8	2.19	356	97.53	365	0.00
SAAB	14	0.09		0.00	16,184	99.91	16,198	0.13
SATURN	274	0.16	277	0.16	168,157	99.67	168,708	1.31
SCION	4	0.02	2	0.01	19,023	99.97	19,029	0.15
SUBARU	8	0.03	3	0.01	30,929	99.96	30,940	0.24
SUZUKI	7	0.02	7	0.02	34,891	99.96	34,905	0.27
TOYOTA	334	0.02	277	0.02	1,354,475	99.95	1,355,086	10.52
VOLVO	28	0.04	24	0.03	76,579	99.93	76,631	0.59
VW	190	0.12	113	0.07	162,626	99.81	162,929	1.26
TOTAL	**9,068**	**0.07**	**6,181**	**0.05**	**12,866,594**	**99.88**	**12,881,843**	**100.00**

Communication Rates by Vehicle Model - To assess communication rates by vehicle models, the following model designation fields were reviewed:

- The "MODEL" field from the vehicle test result tables was seen to have a number of inconsistencies and errors. This is probably because it is a manual keyboard entry.
- veh_modl (derived from the merged registration records) was also seen to have a number of inconsistencies and errors.
- The "MODEL_CD" field from the emission test records was based on table lookup values and therefore appeared to be a more consistent descriptor for the vehicle's model designation. The Texas analyzer specification reports this "model code" is "The NCIC model code or acceptable TCEQ code, otherwise left blank." In order to correlate this "model code" to an actual vehicle model, all vehicle emission test record VINS were decoded using ERG's VIN Decoder, and the vehicle "series" (i.e., model) resulting from this decoding process was merged into the test record. An output table correlating "series" with "model code" was then developed using the most frequently occurring series associated with each model code.

Table 5-9 lists communication rates for each vehicle model code. The series that is shown in the table was derived from the decoded VIN as described above. Records for which model code was missing were excluded from the table. Records for the more uncommon series, i.e. less than 100 inspection records, were also excluded.

The data from the table indicates that only six model codes/vehicle series (580, CW2, DEN, EC3, F25, F35) had successful communication rates that were lower than 99%. Almost all of these were for large pickup trucks, and they comprise a very small portion of the fleet.

5.2.2 TIMS Handling of OBD Codes

ERG analyzed TIMS OBD data to look for proper handling of OBD scanner information by the TIMS. An analysis of the TIMS records for proper handling of readiness, DTCs with and without MIL command, and failure to communicate test dispositions will verify that Texas is handling OBD test results in accordance with program guidelines.

Proper handling of various OBD test outcomes is defined in Parts 85.2207 and 85.2222 of Title 40 of the Code of Federal Regulations and also in various OBD implementation guidance documents issued by the US EPA. Appropriate responses to the various test possibilities are summarized here, and serve as the basis for analysis in this task. The dataset for this analysis included records for OBD inspections between 1 October 2006 and 31 March 2009. Records for

Table 5-9. OBD Communication Rates by Vehicle Model Code for Elevated Communication Failures

Model Code	Series (Model)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model	% of overall tests by model
		Count	Percent	Count	Percent	Count	Percent		
16	Express 2500 2WD	1	0.34	1	0.34	288	99.31	290	0.004
17	Express 3500 2WD	0	0.00	0	0.00	257	100.00	257	0.004
88	Delta 88	1	0.04	0	0.00	2413	99.96	2414	0.037
94	Ram Pickup 1500 2WD	40	0.04	11	0.01	102644	99.95	102695	1.573
98	98 Regency Elite	0	0.00	0	0.00	287	100.00	287	0.004
116	Ram Van/Wagon	0	0.00	0	0.00	125	100.00	125	0.002
133	F250 Super Cab	10	0.65	2	0.13	1522	99.22	1534	0.023
175	Sierra 1500 Pickup 4	0	0.00	0	0.00	177	100.00	177	0.003
180	Sierra 1500 2WD	1	0.06	0	0.00	1580	99.94	1581	0.024
181	Sierra 3500 Pickup 2	0	0.00	0	0.00	105	100.00	105	0.002
184	Savanna 2500 2WD	0	0.00	0	0.00	103	100.00	103	0.002
200	Sentra / 200SX	8	0.10	7	0.09	7648	99.80	7663	0.117
230	SLK230	0	0.00	0	0.00	1469	100.00	1469	0.022
231	Truck Regular Bed	8	0.13	1	0.02	6143	99.85	6152	0.094
240	240SX	4	0.39	1	0.10	1015	99.51	1020	0.016
254	Grand Cherokee Lared	23	0.04	9	0.02	58432	99.95	58464	0.895
300	ES300	54	0.05	21	0.02	114637	99.93	114712	1.757
320	S320	0	0.00	0	0.00	871	100.00	871	0.013
400	LS400	4	0.03	1	0.01	12590	99.96	12595	0.193
420	S420	0	0.00	0	0.00	482	100.00	482	0.007
500	528i	10	0.05	2	0.01	21853	99.95	21865	0.335
550	550 Maranello	0	0.00	0	0.00	167	100.00	167	0.003
580		5	4.59	0	0.00	104	95.41	109	0.002
600		1	0.08	2	0.17	1191	99.75	1194	0.018
626	626	52	0.12	38	0.09	43333	99.79	43423	0.665
700	740iL (Auto)	7	0.10	2	0.03	6984	99.87	6993	0.107
850	850	4	0.13	3	0.10	3083	99.77	3090	0.047
900	900S / 900CS	1	0.10	1	0.10	972	99.79	974	0.015
911	911	0	0.00	0	0.00	459	100.00	459	0.007
960	960	3	0.14	2	0.09	2152	99.77	2157	0.033
22C	CL	2	0.25	0	0.00	809	99.75	811	0.012
23C	CL	5	0.51	0	0.00	979	99.49	984	0.015
25T	TL	3	0.22	0	0.00	1345	99.78	1348	0.021
30C	CL	0	0.00	0	0.00	1724	100.00	1724	0.026

Table 5-9. Continued

Model Code	Series (Model)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model	% of overall tests by model
		Count	Percent	Count	Percent	Count	Percent		
32i	325i	0	0.00	0	0.00	123	100.00	123	0.002
32T	TL	7	0.04	1	0.01	16542	99.95	16550	0.253
35R	RL	4	0.08	1	0.02	4721	99.89	4726	0.072
3GT	3000 GT	3	0.22	2	0.15	1351	99.63	1356	0.021
4RN	4Runner SR5	22	0.04	3	0.01	53346	99.95	53371	0.817
85F	850	2	0.10	1	0.05	1907	99.84	1910	0.029
90A	9000S / 9000CD / 900	0	0.00	0	0.00	107	100.00	107	0.002
AA4	A4	9	0.08	3	0.03	11492	99.90	11504	0.176
AA6	A6	2	0.07	2	0.07	2702	99.85	2706	0.041
AA8	A8	0	0.00	1	0.10	987	99.90	988	0.015
ACC	Accord	97	0.07	33	0.02	135086	99.90	135216	2.071
ACV	Achieva SL/SC	0	0.00	3	0.10	2874	99.90	2877	0.044
AER	Aerostar XLT Wagon	3	0.14	0	0.00	2143	99.86	2146	0.033
ALO	Alero Level II	15	0.05	10	0.03	30007	99.92	30032	0.460
ALT	Altima	70	0.04	79	0.05	160499	99.91	160648	2.460
AMG	Amigo/Rodeo 2WD	1	0.13	0	0.00	792	99.87	793	0.012
ARL	RL	0	0.00	3	0.31	953	99.69	956	0.015
ARN	Arnage Red Label	0	0.00	0	0.00	203	100.00	203	0.003
AS4	A4/S4	1	0.09	2	0.18	1123	99.73	1126	0.017
ASP	Aspire	2	0.12	2	0.12	1732	99.77	1736	0.027
AST	Astro 2WD	19	0.12	3	0.02	16374	99.87	16396	0.251
ATL	TL	0	0.00	1	0.01	9662	99.99	9663	0.148
AUR	Aurora	5	0.08	2	0.03	6176	99.89	6183	0.095
AVA	Avalon	21	0.03	16	0.02	74177	99.95	74214	1.137
AVN	Avenger	12	0.26	8	0.17	4580	99.57	4600	0.070
B23	Pickup (not Cab Plus	0	0.00	0	0.00	605	100.00	605	0.009
B40	Pickup (not Cab Plus	0	0.00	0	0.00	181	100.00	181	0.003
BEE	New Beetle	11	0.08	5	0.04	13062	99.88	13078	0.200
BER	Beretta	1	0.12	0	0.00	853	99.88	854	0.013
BLZ	S10 Blazer 2WD	37	0.08	5	0.01	44068	99.90	44110	0.676
BON	Bonneville SE	7	0.05	5	0.03	14506	99.92	14518	0.222
BOX	986 Boxster	3	0.05	0	0.00	6582	99.95	6585	0.101
BRO	Bronco 4WD	2	0.39	1	0.19	511	99.42	514	0.008
BRZ	Breeze	8	0.11	4	0.05	7454	99.84	7466	0.114
BVD	Bravada 4WD	0	0.00	0	0.00	1879	100.00	1879	0.029
C15	C1500 Pickup 2WD	200	0.07	47	0.02	306906	99.92	307153	4.704

Table 5-9. Continued

Model Code	Series (Model)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model	% of overall tests by model
		Count	Percent	Count	Percent	Count	Percent		
C22	C220	6	0.62	2	0.21	963	99.18	971	0.015
C23	C230	1	0.01	1	0.01	11100	99.98	11102	0.170
C25	C2500 Pickup 2WD	9	0.12	5	0.07	7335	99.81	7349	0.113
C28	C280	2	0.04	4	0.09	4473	99.87	4479	0.069
C35	C3500 Pickup 2WD	3	0.21	2	0.14	1427	99.65	1432	0.022
C70	C70	0	0.00	0	0.00	2236	100.00	2236	0.034
CAB	Cabrio Convertible	9	0.26	4	0.11	3485	99.63	3498	0.054
CAM	Camry	119	0.03	82	0.02	385055	99.95	385256	5.900
CAP	Caprice Classic	1	0.05	1	0.05	1873	99.89	1875	0.029
CAR	911	1	0.05	0	0.00	1925	99.95	1926	0.029
CAT	Catera	2	0.04	1	0.02	5659	99.95	5662	0.087
CAV	Cavalier	183	0.14	117	0.09	126471	99.76	126771	1.941
CEN	Century Custom	12	0.03	6	0.01	45525	99.96	45543	0.697
CHA		1	0.05	1	0.05	2120	99.91	2122	0.032
CI1	Civic del Sol	0	0.00	1	0.19	536	99.81	537	0.008
CIE	Cutlass Ciera SL	2	0.15	0	0.00	1311	99.85	1313	0.020
CIR	Cirrus LXi	4	0.06	4	0.06	6821	99.88	6829	0.105
CIV	Civic	71	0.03	51	0.02	244519	99.95	244641	3.747
CL3	CLK320	0	0.00	1	0.03	3446	99.97	3447	0.053
CL4	CLK430	1	0.03	0	0.00	3214	99.97	3215	0.049
CL5	CL500	1	0.11	0	0.00	925	99.89	926	0.014
CL6	CL600	0	0.00	0	0.00	161	100.00	161	0.002
CNC	Concorde LX/LXi	18	0.10	13	0.07	17636	99.82	17667	0.271
CNT	Contour LX/SE	32	0.13	25	0.10	25455	99.78	25512	0.391
COA	Corolla	62	0.03	30	0.01	224294	99.96	224386	3.436
CON	Continental	3	0.03	3	0.03	9737	99.94	9743	0.149
COU	Cougar	22	0.12	12	0.06	18930	99.82	18964	0.290
CRS	Corsica	6	0.18	2	0.06	3325	99.76	3333	0.051
CRV	CR-V	3	0.01	3	0.01	31000	99.98	31006	0.475
CST	Celica	1	0.01	5	0.03	14649	99.96	14655	0.224
CUT	Cutlass GL	4	0.06	0	0.00	6970	99.94	6974	0.107
CVC	LTD Crown Victoria	31	0.07	10	0.02	46959	99.91	47000	0.720
CVN	Caravan	23	0.05	8	0.02	50284	99.94	50315	0.771
CVT	Corvette	13	0.04	22	0.07	30072	99.88	30107	0.461
CW2	E250 2WD	5	2.49	0	0.00	196	97.51	201	0.003
CW3	E350 Super Wagon	1	0.66	0	0.00	151	99.34	152	0.002

Table 5-9. Continued

Model Code	Series (Model)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model	% of overall tests by model
		Count	Percent	Count	Percent	Count	Percent		
DAK	Dakota 2WD	14	0.06	2	0.01	23611	99.93	23627	0.362
DEN	1500 Suburban 4WD Lu	4	0.98	3	0.74	401	98.28	408	0.006
DEV	DeVille	21	0.03	22	0.03	73118	99.94	73161	1.120
DIA	Diamante LS	13	0.16	17	0.21	7995	99.63	8025	0.123
DIS	Discovery Series II;	4	0.08	0	0.00	5140	99.92	5144	0.079
DLT	Delta 88/88LS	3	0.20	0	0.00	1489	99.80	1492	0.023
DUR	Durango 2WD	41	0.13	3	0.01	30706	99.86	30750	0.471
E32	E320W	11	0.04	5	0.02	28196	99.94	28212	0.432
E42	E420	0	0.00	0	0.00	1954	100.00	1954	0.030
E43	E430W	1	0.05	2	0.10	1920	99.84	1923	0.029
E50	E500W	0	0.00	0	0.00	1407	100.00	1407	0.022
E55	E55AMG	0	0.00	0	0.00	508	100.00	508	0.008
EC2	E250 2WD	12	0.46	6	0.23	2587	99.31	2605	0.040
EC3	E350 2WD	2	0.30	5	0.76	651	98.94	658	0.010
ECH	Echo	2	0.03	1	0.02	6500	99.95	6503	0.100
ECL	Eclipse	42	0.11	46	0.12	36984	99.76	37072	0.568
ELD	Eldorado	1	0.02	1	0.02	6447	99.97	6449	0.099
ELL		0	0.00	0	0.00	376	100.00	376	0.006
ELN	Elantra	58	0.13	45	0.10	43501	99.76	43604	0.668
ENV	Jimmy 4WD	0	0.00	0	0.00	119	100.00	119	0.002
EPD	Expedition	165	0.10	83	0.05	165158	99.85	165406	2.533
ES1	Esteem	0	0.00	0	0.00	923	100.00	923	0.014
ESC	Escort SE	28	0.04	20	0.03	70860	99.93	70908	1.086
EST	Esteem	0	0.00	0	0.00	1288	100.00	1288	0.020
EUR	Eurovan GLS	0	0.00	0	0.00	148	100.00	148	0.002
EXC	Excursion Limited 2W	2	0.34	0	0.00	593	99.66	595	0.009
F10	F150 2WD	0	0.00	1	0.90	110	99.10	111	0.002
F15	F150 2WD	152	0.10	34	0.02	154493	99.88	154679	2.369
F25	F250 Super Cab	88	2.55	6	0.17	3353	97.27	3447	0.053
F35	F350 Super Duty 2WD	10	2.41	1	0.24	404	97.35	415	0.006
FBD	Firebird	11	0.06	16	0.08	19556	99.86	19583	0.300
FLE	Fleetwood	2	0.26	0	0.00	769	99.74	771	0.012
FOC	Focus SE	18	0.07	15	0.06	24898	99.87	24931	0.382
FOR	Forester	0	0.00	0	0.00	1105	100.00	1105	0.017
FRT	Pickup King Cab	13	0.04	6	0.02	33295	99.94	33314	0.510
G15	Savanna 1500 2WD	0	0.00	0	0.00	409	100.00	409	0.006

Table 5-9. Continued

Model Code	Series (Model)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model	% of overall tests by model
		Count	Percent	Count	Percent	Count	Percent		
G20	G20	5	0.08	0	0.00	6581	99.92	6586	0.101
G35	G35	0	0.00	0	0.00	12433	100.00	12433	0.190
GAL	Galant ES / GTZ / LS	66	0.10	49	0.08	63763	99.82	63878	0.978
GCK	Grand Cherokee 2WD	4	0.03	4	0.03	12884	99.94	12892	0.197
GOL	Golf / GTI / Jetta W	11	0.21	3	0.06	5239	99.73	5253	0.080
GRA	Grand Prix GT	62	0.10	26	0.04	61596	99.86	61684	0.945
GRM	Grand Am SE	36	0.04	13	0.02	81361	99.94	81410	1.247
GS3	GS300/GS430	5	0.02	6	0.03	21906	99.95	21917	0.336
GS4	GS400	1	0.03	0	0.00	2890	99.97	2891	0.044
GT	Mustang GT	1	0.40	0	0.00	249	99.60	250	0.004
GTI	Golf / GTI / Jetta W	3	0.06	3	0.06	4809	99.88	4815	0.074
GTO	G T O	2	0.09	2	0.09	2265	99.82	2269	0.035
GVT	Vitara / Grand Vitar	2	0.07	0	0.00	3039	99.93	3041	0.047
HOM	Sonoma Pickup 2WD	0	0.00	0	0.00	223	100.00	223	0.003
hom	Sonoma Pickup 2WD	2	0.13	0	0.00	1512	99.87	1514	0.023
HUM		0	0.00	0	0.00	123	100.00	123	0.002
I30	I30	8	0.04	12	0.05	22529	99.91	22549	0.345
IMP	Impala	31	0.02	23	0.02	126885	99.96	126939	1.944
INT	Intrepid SE	51	0.08	40	0.06	67010	99.86	67101	1.028
J30	J30	2	0.06	4	0.13	3088	99.81	3094	0.047
JET	Jetta	73	0.11	50	0.08	64253	99.81	64376	0.986
JMY	Jimmy 2WD	5	0.08	2	0.03	6077	99.88	6084	0.093
L45	LX450	0	0.00	0	0.00	483	100.00	483	0.007
L47	LX470	0	0.00	1	0.02	4861	99.98	4862	0.074
LAN	Lancer ES	11	0.05	9	0.04	20299	99.90	20319	0.311
LCR	Land Cruiser	4	0.09	1	0.02	4340	99.88	4345	0.067
LEG	Legacy	5	0.05	6	0.06	9890	99.89	9901	0.152
LES	LeSabre Custom	10	0.04	3	0.01	24683	99.95	24696	0.378
LHS	LHS	5	0.09	4	0.07	5641	99.84	5650	0.087
LIM	Incomplete	0	0.00	0	0.00	216	100.00	216	0.003
LS6	LS	5	0.04	5	0.04	12634	99.92	12644	0.194
LSS	Delta 88LSS	1	0.10	0	0.00	973	99.90	974	0.015
LUM	Lumina LS	24	0.07	13	0.04	36521	99.90	36558	0.560
M3	M3	23	0.48	21	0.44	4731	99.08	4775	0.073
M5	M5	3	0.33	1	0.11	917	99.57	921	0.014
MAG		0	0.00	6	0.14	4391	99.86	4397	0.067

Table 5-9. Continued

Model Code	Series (Model)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model	% of overall tests by model
		Count	Percent	Count	Percent	Count	Percent		
MAL	Malibu LS	45	0.04	42	0.03	128331	99.93	128418	1.967
MAR	Grand Marquis LS	15	0.05	4	0.01	31536	99.94	31555	0.483
MAU	Grand Marquis LS	0	0.00	0	0.00	436	100.00	436	0.007
MAX	Maxima	46	0.04	60	0.06	103731	99.90	103837	1.590
MET	Geo Metro LSi	4	0.09	0	0.00	4688	99.91	4692	0.072
MGO	Montego Premier	2	0.11	3	0.17	1788	99.72	1793	0.027
MIA	MX5 Miata	20	0.16	5	0.04	12871	99.81	12896	0.197
MIL	Millenia	2	0.02	7	0.07	9368	99.90	9377	0.144
MIR	Mirage	17	0.10	14	0.08	16648	99.81	16679	0.255
MK8	Mark VIII	1	0.14	0	0.00	729	99.86	730	0.011
ML3	ML320	2	0.04	0	0.00	5073	99.96	5075	0.078
ML4	ML430	0	0.00	0	0.00	970	100.00	970	0.015
MOC	Monte Carlo LS	6	0.02	7	0.02	30729	99.96	30742	0.471
MON	Montero Sport 2WD	5	0.03	3	0.02	16086	99.95	16094	0.246
MPV	MPV	3	0.05	2	0.03	6281	99.92	6286	0.096
MR2	MR2 Spyder	1	0.04	1	0.04	2291	99.91	2293	0.035
MTA	Montana 2WD	2	0.04	1	0.02	4768	99.94	4771	0.073
MTN	Mountaineer 2WD	8	0.10	0	0.00	8352	99.90	8360	0.128
MUS	Mustang	56	0.04	34	0.02	144609	99.94	144699	2.216
MX6	626 / MX6	0	0.00	0	0.00	275	100.00	275	0.004
MYS	Mystique GS	10	0.14	6	0.08	7147	99.78	7163	0.110
NAV	Navigator 2WD	72	0.18	34	0.09	39861	99.73	39967	0.612
NEO	Neon ES	26	0.04	24	0.03	72559	99.93	72609	1.112
NSX	NSX	2	0.68	0	0.00	292	99.32	294	0.005
NUB	Nubira	2	0.10	1	0.05	1947	99.85	1950	0.030
OAS	Trooper 4WD	0	0.00	0	0.00	202	100.00	202	0.003
ODY	Odyssey	10	0.03	3	0.01	30891	99.96	30904	0.473
PAS	Passat	43	0.11	16	0.04	38647	99.85	38706	0.593
PAV	Park Avenue	1	0.01	0	0.00	7165	99.99	7166	0.110
PRE	Prelude	8	0.09	3	0.04	8500	99.87	8511	0.130
PRI	Geo Prizm	13	0.06	58	0.25	22729	99.69	22800	0.349
PRO	ProtGgG	40	0.09	52	0.12	43070	99.79	43162	0.661
PRV	Previa 2WD	1	0.31	0	0.00	320	99.69	321	0.005
PRW	Prowler	0	0.00	0	0.00	296	100.00	296	0.005
PTH	Pathfinder	7	0.03	1	0.00	21167	99.96	21175	0.324
PUP	Pickup King Cab	0	0.00	0	0.00	392	100.00	392	0.006

Table 5-9. Continued

Model Code	Series (Model)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model	% of overall tests by model
		Count	Percent	Count	Percent	Count	Percent		
Q45	Q45	3	0.04	2	0.03	7604	99.93	7609	0.117
QST	Quest	3	0.03	1	0.01	11339	99.96	11343	0.174
QTO	A6	3	0.08	0	0.00	3926	99.92	3929	0.060
QUA		0	0.00	0	0.00	165	100.00	165	0.003
QX4	Pathfinder	0	0.00	0	0.00	527	100.00	527	0.008
QXA	Pathfinder	0	0.00	1	0.02	4268	99.98	4269	0.065
R25	Ram Pickup 2WD	1	0.10	0	0.00	1047	99.90	1048	0.016
RAV	RAV4	5	0.03	0	0.00	19754	99.97	19759	0.303
REG	Regal LS	5	0.02	4	0.02	23907	99.96	23916	0.366
RIV	Riviera	4	0.19	1	0.05	2153	99.77	2158	0.033
RNG	Ranger 2WD	35	0.07	9	0.02	47036	99.91	47080	0.721
ROA	RoadMaster ITT Limit	0	0.00	1	0.09	1121	99.91	1122	0.017
ROD	Rodeo 2WD	13	0.07	5	0.03	19066	99.91	19084	0.292
RRV	Range Rover HSE	2	0.04	0	0.00	4560	99.96	4562	0.070
RST	Z3	0	0.00	0	0.00	174	100.00	174	0.003
RX3	RX300	5	0.03	1	0.01	16807	99.96	16813	0.257
S10	S10 Pickup 2WD	40	0.13	10	0.03	29624	99.83	29674	0.454
S20	S2000	4	0.11	1	0.03	3504	99.86	3509	0.054
S30	SC300	1	0.06	0	0.00	1633	99.94	1634	0.025
S40	S40 / V40	5	0.07	4	0.05	7483	99.88	7492	0.115
S70	S70 / V70	4	0.04	2	0.02	10614	99.94	10620	0.163
S80	S80	1	0.01	0	0.00	10450	99.99	10451	0.160
S90	S90 / V90	2	0.18	2	0.18	1118	99.64	1122	0.017
SAB	Sable GS	29	0.08	16	0.04	37649	99.88	37694	0.577
SAF	Safari 2WD	3	0.08	0	0.00	3717	99.92	3720	0.057
SAV	Savanna 1500 2WD	0	0.00	0	0.00	1409	100.00	1409	0.022
SC	SC2 / SL1 / SW1	50	0.21	37	0.16	23557	99.63	23644	0.362
SDK	Sidekick 4dr 4WD	1	0.26	0	0.00	390	99.74	391	0.006
SEB	Sebring LXi	45	0.08	37	0.06	59058	99.86	59140	0.906
SEN	Sentra	52	0.06	53	0.06	85045	99.88	85150	1.304
SEP	Sephia/Spectra	16	0.16	8	0.08	10017	99.76	10041	0.154
SEV	SLS	6	0.04	1	0.01	13613	99.95	13620	0.209
SFT	Swift	0	0.00	1	0.63	159	99.38	160	0.002
SIL	Silhouette	1	0.03	0	0.00	3486	99.97	3487	0.053
SKY	Skylark	5	0.16	9	0.29	3073	99.55	3087	0.047
SL	SL2 / SW2	113	0.22	113	0.22	51959	99.57	52185	0.799

Table 5-9. Continued

Model Code	Series (Model)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model	% of overall tests by model
		Count	Percent	Count	Percent	Count	Percent		
SL5	SL500R	1	0.02	1	0.02	4028	99.95	4030	0.062
SL6	SL600	0	0.00	1	0.33	306	99.67	307	0.005
SLX	SLX 4WD	0	0.00	0	0.00	110	100.00	110	0.002
SNA	Sienna LE	2	0.01	0	0.00	32302	99.99	32304	0.495
SNF	Sunfire	51	0.14	37	0.10	36511	99.76	36599	0.560
SOL	Solara	0	0.00	0	0.00	716	100.00	716	0.011
SON	Sonata	20	0.05	7	0.02	41179	99.93	41206	0.631
SPT	Sportage	1	0.01	1	0.01	9734	99.98	9736	0.149
STA	Stratus SE	40	0.07	35	0.06	55557	99.87	55632	0.852
STS	STS	0	0.00	0	0.00	1500	100.00	1500	0.023
SUB	C1500 Suburban 2WD	10	0.04	11	0.04	26844	99.92	26865	0.411
SUP	Supra	0	0.00	0	0.00	306	100.00	306	0.005
SW	SL2 / SW2	9	0.34	12	0.45	2662	99.22	2683	0.041
SWI	Geo Metro LSi	0	0.00	0	0.00	244	100.00	244	0.004
T10	T100 XTRACAB 2WD	0	0.00	0	0.00	2161	100.00	2161	0.033
TAC	Tacoma Deluxe	20	0.04	2	0.00	46056	99.95	46078	0.706
TAH	Tahoe 2WD	35	0.04	5	0.01	81967	99.95	82007	1.256
TAL		1	0.16	1	0.16	612	99.67	614	0.009
TAM	Formula / Trans Am	0	0.00	0	0.00	378	100.00	378	0.006
TAU	Taurus SE	121	0.06	91	0.05	195243	99.89	195455	2.993
TC	Scion tC	2	0.05	0	0.00	3687	99.95	3689	0.056
TER	Tercel	2	0.04	4	0.09	4678	99.87	4684	0.072
THU	Thunderbird LX	12	0.09	11	0.08	13504	99.83	13527	0.207
TIB	Tiburon	7	0.07	3	0.03	9952	99.90	9962	0.153
TL	TL	0	0.00	0	0.00	5369	100.00	5369	0.082
TOW	Town Car Signature	91	0.10	63	0.07	89413	99.83	89567	1.372
TRA	Tracer LS	3	0.07	1	0.02	4259	99.91	4263	0.065
TRK	Tracker 2WD	0	0.00	0	0.00	1376	100.00	1376	0.021
TRP	Trooper 4WD	6	0.14	0	0.00	4204	99.86	4210	0.064
TSP	Transport	1	0.07	0	0.00	1426	99.93	1427	0.022
TUN	Tundra SR5	17	0.06	6	0.02	30821	99.93	30844	0.472
V15	Ram Pickup 2WD	20	0.08	4	0.02	25335	99.91	25359	0.388
V25	Ram Van/Wagon	1	0.07	0	0.00	1464	99.93	1465	0.022
V35	Ram Wagon Bus	0	0.00	0	0.00	207	100.00	207	0.003
V40	S40 / V40	0	0.00	3	0.69	434	99.31	437	0.007
V70	S70 / V70	0	0.00	2	0.05	4048	99.95	4050	0.062

Table 5-9. Continued

Model Code	Series (Model)	DLC is damaged, inaccessible, or cannot be found		Vehicle will not communicate with analyzer		Vehicle successfully communicates with analyzer		Total count of tests by model	% of overall tests by model
		Count	Percent	Count	Percent	Count	Percent		
VAN	Vandenplas LWB	0	0.00	0	0.00	2172	100.00	2172	0.033
VCS	Vehicross 4WD	0	0.00	0	0.00	108	100.00	108	0.002
VEN	Venture 2WD Extended	4	0.10	3	0.07	4067	99.83	4074	0.062
VGR	Villager Wagon	3	0.06	1	0.02	5419	99.93	5423	0.083
VIP	Viper SRT-10	0	0.00	0	0.00	1285	100.00	1285	0.020
VIS		1	0.39	0	0.00	257	99.61	258	0.004
VIT	Vitara / Grand Vitar	0	0.00	0	0.00	898	100.00	898	0.014
VOY	Voyager	4	0.03	2	0.02	12549	99.95	12555	0.192
WIN	Windstar GL Wagon	18	0.07	5	0.02	25769	99.91	25792	0.395
WRG	Wrangler 4WD	4	0.01	7	0.03	27530	99.96	27541	0.422
XJ	XJ Sport	0	0.00	1	0.63	157	99.37	158	0.002
XJ6	XJ6 (USA) / Sovereig	0	0.00	0	0.00	1698	100.00	1698	0.026
XJ8	XJ	3	0.04	4	0.05	7837	99.91	7844	0.120
XJR	XJR	0	0.00	0	0.00	1452	100.00	1452	0.022
XJS	XJS	1	0.53	0	0.00	187	99.47	188	0.003
XK8	XK8	1	0.07	0	0.00	1456	99.93	1457	0.022
XPL	Explorer XL	69	0.07	8	0.01	105225	99.93	105302	1.613
XTE	Xterra	2	0.01	0	0.00	25413	99.99	25415	0.389
XXX	Wrangler 4WD	54	0.10	8	0.02	51916	99.88	51978	0.796
YUK	Yukon 2WD	23	0.07	4	0.01	31715	99.91	31742	0.486
Z3	Z3	1	0.03	3	0.10	3042	99.87	3046	0.047
Z3C	Z3	0	0.00	0	0.00	724	100.00	724	0.011
Z3R	Z3	1	0.11	0	0.00	942	99.89	943	0.014
Z8	Z8	0	0.00	0	0.00	103	100.00	103	0.002
ZEP		0	0.00	0	0.00	105	100.00	105	0.002
	TOTAL	**4231**	**0.06**	**2457**	**0.04**	**6523090**	**99.90**	**6529778**	**100.000**

inspections that were aborted were excluded from the dataset, as were records for which either the OBD result or the overall result was not "P"ass or "F"ail. This left 13,529,388 records in the dataset. Because this analysis was performed with the goal of determining whether OBD guidelines are enforced, only records for light-duty vehicles were used. Records for heavy-duty vehicles (>8500 lbs GVWR) for which the OBD test pass/fail results are not enforced and for vehicles with no GVWR given (because these might be heavy-duty vehicles) were also removed from the dataset, leaving 13,000,891 records in the dataset*. Re-test inspections on OBD vehicles that included a safety or gas cap re-inspection, but did not include an OBD re-inspection (because the vehicle had passed OBD in a preceding inspection) were also excluded from the dataset, leaving 12,989,744 records in the dataset. Finally, the model codes in Table 5-9 are from the VID, and the series codes were obtained using the ERG VIN decoder. In some cases we were not able to assign a series code match to the model code, and in those instances, the series code was left blank.

Diagnostic Link Connector Communication Status – According to federal guidelines, a diagnostic link connector (DLC) that is missing, tampered, or otherwise inoperable is a basis for failure, but the vehicle may be "rejected" for a DLC that is inaccessible or cannot be located. Failure to communicate with an OBD analyzer is also a basis for failure. To perform this analysis, the result stored in the "OBD2_DLC_RES" field was compared with that in the "OBD2_PF_FLAG" field. No test results with a "D" (damaged), "N" (connected but will not communicate), "L" (inspector cannot find DLC), or "I" (DLC is inaccessible) in the "OBD2_DLC_RES" should have a "P" in the "OBD2_PF_FLAG". Results of this analysis are shown in Table 5-10.

Table 5-10. Comparison of DLC Communication Status with Overall OBD Test Results

DLC Communication Status	Overall OBD Test Results	
	Fail	**Pass**
"D" (damaged)	4,715	0
"I" (DLC is inaccessible)	2,150	1
"L" (inspector cannot find DLC)	1,749	50
"N" (connected but will not communicate)	6,028	0
Total count of "D", "I", "L", and "N" Tests	14,642	51
"P" (communication successful)	599,604	12,375,447
Total	**614,246**	**12,375,498**

* HD vehicles were identified using the tx96_type field equal to 1 and the tx96_gvw_actual field being greater than zero but less than 8,501.

As can be seen in the table, 51 test records have a DLC communication status of “D”, “I”, “L”, or “N”, yet have an OBD test result of “pass”. For these records, it was noted that no result was given for monitor readiness (which should have been a “pass” in order to pass the OBD inspection) or for number of fault codes stored (which should have been present as well). Additionally, no fields indicate that a fallback tailpipe inspection was performed for those records. It is not clear what led to the passing result for those 51 records. In conclusion, the DLC fail to communicate was enforced on the vast majority of OBD tests conducted on light-duty vehicles during the period of evaluation.

Because successful communication with the OBD system is critical for all other OBD results, the OBD records with OBD2_DLC_RES results other than “P” were removed from the dataset for the other analyses that comprise the remainder of this section. This left 12,975,051 records in the dataset.

Agreement between OBD test result and overall test result – A vehicle that fails the OBD inspection should fail the overall inspection, excluding any test exceptions such as converting to a backup tailpipe test.

To determine if OBD failures are properly enforced, that is, reflected in the overall inspection disposition, a query was performed to quantify the number of vehicles that failed the OBD portion of the test (“F” in the “OBD2_PF_FL” field) but passed the overall OBD test (“P” in the “OVERALL_RESULTS” field). Table 5-11 shows that only 167 tests were recorded which failed the OBD portion of the test but passed the overall test. Additional analysis was performed to determine the cause of this apparent discrepancy. 162 of these records contained a passing result for the tailpipe inspection, indicating that these tests were converted to a fallback tailpipe test. For the remaining 5 records, no explanation for the overall passing result could be found. This is a very small fraction of the total number of inspections performed; more than 99.99% of OBD inspections have agreement between the OBD result and the overall test result.

Table 5-11. Comparison of OBD Test Result with Overall Test Result

Result of OBD Test	Overall Test Result				Total	
	Fail		Pass			
Fail	599,437	4.6	167	0.0	599,604	4.6
Pass	341,148	2.6	12,034,299	92.7	12,375,447	95.4
Total	940,585	7.2	12,034,466	92.8	12,975,051	100.0

Inspector-Entered Malfunction Indicator Light (MIL) bulb check: This is also referred to as the Key On/Engine Off (KOEO) check (or MIL bulb check). The inspector turns the vehicle's ignition key to the "on" position, but does not start the vehicle, in order to illuminate the MIL. Results are manually entered into the analyzer via keyboard by the inspector. If the MIL does not illuminate, the vehicle should fail this OBD portion of the inspection.

To perform this analysis, the results for the inspector keyboard-entered MIL bulb check ("OBD2_MIL_CHECK" field of the test record) were compared with results of the overall OBD test result ("OBD2_PF_FLAG" field), to ensure that a MIL bulb check failure always results in an OBD test failure. The "OBD2_MIL_CHECK" results are "Y" or "K", which is a pass (yes, the MIL did illuminate), and "N", which is a fail (no, the MIL did not illuminate). Table 5-12 shows that one record was found which contained no result for the KOEO MIL Bulb Check Result; rather than passing, a blank result should prevent the inspection from being completed (or a certificate from being issued). Additionally, 6 records were found where a KOEO MIL result of "N" (fail) did not receive the failing OBD result that they should have received. However, 7 records out of 13 million is a very small fraction of the total.

Table 5-12. Comparison of KOEO MIL Bulb Check Result with Overall OBD Test Result

Result of KOEO MIL Bulb Check	Overall OBD Test Result		
	Fail	**Pass**	**Total**
<blank>	0	1	1
N (fail)	20,363	6	20,369
K (pass)	537	29,683	30,220
P (pass)	578,704	12,345,758	12,924,462
Total	**599,604**	**12,375,447**	**12,975,051**

Inspector-Entered Engine-Running MIL Illumination Status – The key-on engine running result manually entered by the inspector is a basis for failure. No vehicle with an "F" in the "OBD2_MIL_ON_RUN" field should have a "P" in the "OBD2_PF_FLAG" field of the OBD test record. The "OBD2_MIL_ON_RUN" results are "Y", which is a pass (Y = MIL turned off after the vehicle was started) or "N", which is a fail (N = MIL stayed illuminated after the vehicle was started). Table 5-13 shows that the MIL Illumination Status appears to be enforced as a condition for OBD failure: no inspections were recorded with a MIL Illumination status of "N" and an overall OBD result of "P". However, since the Key-On-Engine-Running MIL Illumination Status is manually entered by the inspector, the accuracy of this entry is subject to human error or possible fraud.

Table 5-13. Comparison of Inspector-Entered MIL Illumination Status (Engine Running) with Overall OBD Test Result

Result of MIL Illumination Status	Overall OBD Test Result		Total
	Fail	Pass	
<blank>	1	0	1
N (Fail)	107,448	0	107,448
Y (Pass)	492,155	12,375,447	12,867,603
Total	599,604	12,375,447	12,975,051

MIL commanded on – A vehicle with the MIL commanded on and with stored emission control system (generic P0) DTCs should fail the OBD inspection, regardless of readiness status. Manufacturer-specific DTCs are ignored in this pass/fail determination. To perform this analysis, all OBD test records were reviewed to determine the overall OBD pass/fail status in comparison with the downloaded MIL command status results. Specifically, any vehicle with "F" in the "OBD2_MIL_STATUS" should also have "F" in the "OBD2_PF_FLAG" field (if DTCs are present). Table 5-14 provides results of this review. It can be seen that 68,361 test records (0.5% of all OBD test records) have a MIL commanded on status yet receive an overall OBD pass result. However, 68,360 of these tests had no stored DTCs, in which case it is appropriate to pass the test. The single remaining inspection had one DTC stored, and should have resulted in a failed OBD result. In conclusion, the downloaded OBD MIL command status was enforced for almost all OBD tests conducted on light-duty vehicles (< 8500 lbs. GVWR) with stored DTCs during the period of evaluation.

Table 5-14. Comparison of Downloaded MIL Command Status with Overall OBD Test Result

Result of Downloaded MIL Status	Overall OBD Test Result				Total	
	Fail		Pass			
Fail	252,890	1.9	68,361	0.5	321,251	2.5
Pass	346,714	2.7	12,307,086	94.9	12,653,800	97.5
Total	599,604	4.6	12,375,447	95.4	12,975,051	100.0

Readiness Evaluation – Federal guidelines recommend two or fewer unset non-continuous monitors be allowed for 1996-2000 vehicles, and only one or no unset non-continuous monitors be allowed for 2001 and newer vehicles. Vehicles with higher counts of unset non-continuous monitors should not receive a pass result. They should be failed or rejected on the basis of the OBD system's readiness status. Until October 15, 2008, however, Texas used readiness criteria that were slightly different from the federal guidelines: two or fewer unset non-continuous monitors were used as the requirement for vehicles of all model years. After October 15, 2008, Texas changed the criteria to match the federal limits of two unset monitors for 1996-2000 vehicles, and one unset monitor for 2001 and newer vehicles.

Consequently, Results in this section are presented separately for inspections performed before and after October 15, 2008

Certain vehicles that are designated as “transitional vehicles” are permitted to receive a tailpipe inspection if they are found to be “not ready” based on non-continuous monitor status at the time of an OBD inspection. To prevent any confusion of the results, these vehicles were excluded from this analysis of readiness. 33,994 transitional vehicles were excluded, leaving 12,941,057 vehicles in the dataset for this analysis.

To perform this analysis, the OBD readiness status of test records was compared on a model-year basis to evaluate conformance with Texas’ guidelines. Prior to October 15, 2008, vehicles of any model year with three or more “not ready” non-continuous monitors should have an OBD readiness failure (“F” in the “OBD2_READY_RES” field of the test record), and an OBD test result of fail (“F” in the “OBD2_PF_FLAG” field of the test record). Vehicles with two or fewer “not ready” non-continuous monitors should have an OBD readiness result of pass (“P” in the “OBD2_READY_RES” of the test record). After October 15, 2008, 2001 and newer vehicles with two or more “not ready” non-continuous monitors should have an OBD readiness failure (“F” in the “OBD2_READY_RES” of the test record), and an OBD test record result of fail (“F” in the “OBD2_PF_FLAG” field of the test record), while 2001 and newer vehicles with one or fewer “not ready” non-continuous monitors should have an OBD readiness result of pass (“P” in the “OBD2_READY_RES” field of the test record).

Table 5-15 compares OBD readiness status with the number of unset monitors for all OBD tests. Only non-continuous and supported monitors are presented in this comparison.

Table 5-15. Unset Monitors vs. Test Readiness Status for Inspections Prior to October 15, 2008

Count of Unset Non-Continuous Monitors	Counts of Tests of Vehicles Model Year 1996 through 2000		Counts of Tests of Vehicles Model Year 2001 and newer	
	OBD “Not Ready”	OBD “Ready”	OBD “Not Ready”	OBD “Ready”
0	1	3,051,381	2	5,745,878
1	0	451,727	0	373,973
2	0	263,172	441	179,770
3	72,134	910	53,405	25
4	50,712	555	36,137	4
5	33,541	367	19,094	0
6	1,073	0	1,001	0
7	0	0	2	0
8	0	0	2	0
Total Count	157,461	3,768,112	110,084	6,299,650

Results in Table 5-15 (for the period before October 15, 2008) show that a small number of tests (a total of 3) appear to have received an OBD "not ready" status despite having no unset monitors. Also, a larger number of vehicles with three or more unset readiness monitors still received a readiness result of "pass" (1,832 model year 1996-2000 vehicle tests and 29 model year 2001 and newer vehicle tests). Of these 1,861 records, all but 6 were conducted on a single type of analyzer. Additionally, all of them occur before or during April of 2008. After April of 2008, only two additional records were collected with OBD as "ready" for vehicles with more than two unset monitors.

Results in Table 5-16 (for the period after October 15, 2008) show that 1,054 inspections had a "ready" status for a 2001 and newer vehicle with 2 unset monitors. Most of these result from the transition that occurred on October 15, 2008: 785 of them occurred between October 16 and October 19, 2008. No other disagreements between the number of unset monitors and the OBD readiness result were seen for the post-October 15, 2008, results.

Table 5-16. Unset Monitors vs. Test Readiness Status for Inspections After October 15, 2008

Count of Unset Non-Continuous Monitors	Counts of Tests of Vehicles Model Year 1996 through 2000		Counts of Tests of Vehicles Model Year 2001 and newer	
	OBD "Not Ready"	OBD "Ready"	OBD "Not Ready"	OBD "Ready"
0	0	602,053	0	1,597,074
1	0	108,391	0	141,063
2	0	58,489	29,052	1,054
3	16,468	0	16,313	0
4	11,511	0	10,655	0
5	7,694	0	5,412	0
6	251	0	269	0
7	1	0	0	0
8	0	0	0	0
Total Count	35,925	768,933	61,701	1,739,191

To summarize, the Texas I/M program allowed two non-continuous monitors to be unset for OBD "readiness" for 1996 and newer model year vehicles until October 15, 2008. After October 15, 2008, the Texas I/M program allowed two non-continuous monitors to be unset for OBD "readiness" for 1996-2000 model year vehicles, and one non-continuous monitor to be unset for OBD "readiness" for 2001 and newer model year vehicles. Additionally, three or more unset monitors were allowed in 1,866 inspections by one analyzer type until April 2008, after which they were not allowed.

Readiness Evaluation: Comparison of readiness result with overall pass/fail result – The pass/fail disposition of the readiness result field of the test record was compared with the overall OBD test disposition to see if any vehicles with a "not ready" status (as determined automatically by the analyzer) received an overall OBD test result of "pass". To perform this analysis, the "OBD2_READY_RES" field was compared to the "OBD2_PF_FLAG" fields in the analyzer OBD test records. Note that certain vehicles that are designated as "transitional vehicles" are permitted to receive a tailpipe inspection if they are found to be not ready (based on non-continuous monitor status) at the time of an OBD inspection. As described earlier, to prevent any confusion of the results, these vehicles were excluded from this analysis of readiness. 33,994 transition vehicles were excluded, leaving 12,941,057 vehicles in the dataset for this analysis. The results are shown in Table 5-17. Only 10 of the vehicles with a "not ready" status received an overall "pass" result for the OBD portion of the test. This indicates that the OBD readiness status (as determined by the analyzer and stored in the OBD2_READY_RES" field of the test record) was almost always enforced for OBD tests performed during the period of evaluation.

Table 5-17. Comparison of Readiness Status Field with Overall OBD Test Result

Readiness Status Check	Overall OBD Test Result				Total	
	Fail		Pass			
Fail (Not Ready)	365,161	2.8%	10	0.0%	365,171	2.8%
Pass (Ready)	231,887	1.8%	12,343,999	95.4%	12,575,886	97.2%
Total	597,048	4.6%	12,344,009	95.4%	12,941,057	100.0%

5.2.3 OBD Non-Compliance by Station/Inspector

In Sections 5.2.1 and 5.2.2, OBD DLC communication rates were evaluated, and OBD inspection information from the TIMS database was evaluated. Another possible form that OBD non-compliance could take is that of actions on the part of individual I/M technicians who perform the OBD inspection. As was seen in Section 5.2.2, analyzer logic automatically determines OBD test outcomes based on downloaded results; however, there are a few points during an OBD inspection at which the inspector manually enters information. These points are worth checking for systematic non-compliance, because failure to comply with vehicle information requirements could be an indicator of cases of larger non-compliance or fraud issues, and at the very least, does indicate compromised accuracy of the TIMS data that is collected.

5.2.3.1 Consistently Entering Repair Type as "Misc"

Repairs that are performed are categorized by inspectors into five different types: fuel system, ignition/electrical system, emissions system, engine-mechanical, and miscellaneous repairs. Miscellaneous repairs accounted for approximately one-fifth of the repairs recorded in the TIMS during the most recent analysis period. For certain stations/inspectors, miscellaneous repairs account for much more than that. Similarly, repairs performed must also be recorded with an associated repair cost. Repairs recorded with a cost of $0 accounted for approximately four-fifths of the values in the TIMS during the most recent analysis period, and for certain stations/inspectors, zero-cost repairs account for even more than that. The rate at which repairs of "Misc" type or zero cost are entered has been increasing slightly over the past several years, as shown in Figure 5-2. A summary of inspectors with a high percentage of miscellaneous repairs in 2008-2009 is presented in Table 5-18, and a summary of inspectors with a high percentage of zero-cost repairs is presented in Table 5-19. Any inspectors who performed fewer than 100 inspections over the two year period were excluded from the results. Given this large percentage of repairs being entered as $0, ERG recommends TCEQ consider enhancing the analyzer software to prevent invalid data entry. This would also be beneficial in any program evaluation effort where the one could more easily tie the repair to the OBD DTC.

Figure 5-2. Annual Rate of Repairs with Repair Cost=$0 or Repair Type="Misc"

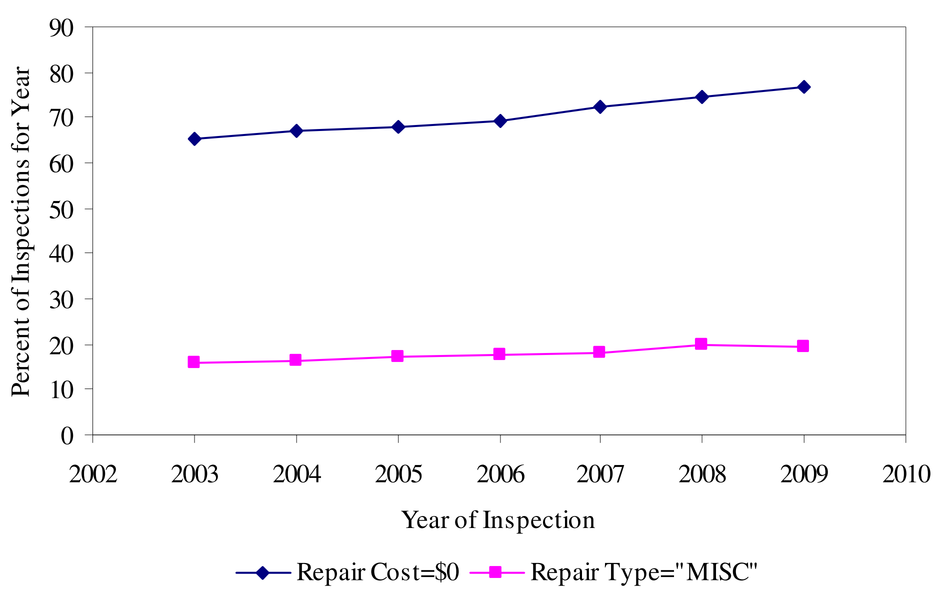


Table 5-18. Miscellaneous Repair Percentage

Station ID	Inspector ID	# of Non-Misc Repairs	# of Misc Repairs	Total	Misc %
6P18784	22051755	0	500	500	100.0
6P34022	02890193	0	245	245	100.0
1P37446	12756222	0	210	210	100.0
2P12877	04053122	0	193	193	100.0
1P27817	07442573	0	172	172	100.0
1P31701	22052993	0	165	165	100.0
1P17052	05933086	0	165	165	100.0
1P38108	13267446	0	160	160	100.0
1P34877	01605161	0	157	157	100.0
2P12877	01536871	0	146	146	100.0
1P37118	10388670	0	143	143	100.0
1P38474	21132943	0	138	138	100.0
1P08007	28713227	0	137	137	100.0
2P37516	12492720	0	121	121	100.0
1P18013	10733394	0	112	112	100.0
1P37937	14404121	0	111	111	100.0
6P38364	14130743	0	104	104	100.0
2P38458	27205565	0	104	104	100.0
1P30749	07241333	1	305	306	99.7
1P37169	14967035	1	299	300	99.7

Table 5-19. Zero-Cost Repair Percentage

Station ID	Inspector ID	# of Non-Zero-Cost Repairs	No. Zero-Cost Repairs	Total	Zero %
1P11839	25194617	0	474	474	100
1P08007	12477891	0	466	466	100
1P36419	24901515	0	462	462	100
2P37904	14648415	0	359	359	100
2P36385	13464288	0	357	357	100
1P31959	03716940	0	356	356	100
1P31462	09950741	0	350	350	100
6P00529	07736504	0	343	343	100
2P36385	13301036	0	334	334	100
2P36385	17240167	0	320	320	100
1P34877	15460098	0	319	319	100
1P35639	22061926	0	315	315	100
2P36378	10209242	0	312	312	100
1P30749	07241333	0	306	306	100
1P37169	14967035	0	300	300	100
1P36641	16109445	0	286	286	100
6P37967	22170283	0	278	278	100
2P12506	16751431	0	272	272	100
1P32582	14568319	0	253	253	100
2P30213	00870817	0	252	252	100

5.2.3.2 VIN Check Digit Errors

For every vehicle inspection, the VIN is recorded in the test record. For approximately 0.75% of the VINs on record for 2008-2009, the VIN either has a bad check digit or an invalid character. Some stations were found to have an unusually high percentage of incorrect VINs. The rate for bad check digits has been decreasing over the last several years, as shown in Figure 5-3; the 2009 rate is one-third the 2003 rate. A summary of inspectors with a high frequency of VIN check digit errors is presented in Table 5-20. Inspections performed in 2008 and 2009 were used for the table; inspectors with fewer than 100 observations were excluded. It is possible the stations with a high percentage of invalid VINs are manually entering these values instead of using bar-code scanners. Many states have a lockout feature in their analyzer software that requires regular use of the bar-code scanner and Texas may want to consider implementing a similar lockout requirement in the next round of software updates.

Figure 5-3. Fraction of OBD Inspection Records with an Error in VIN Check Digit

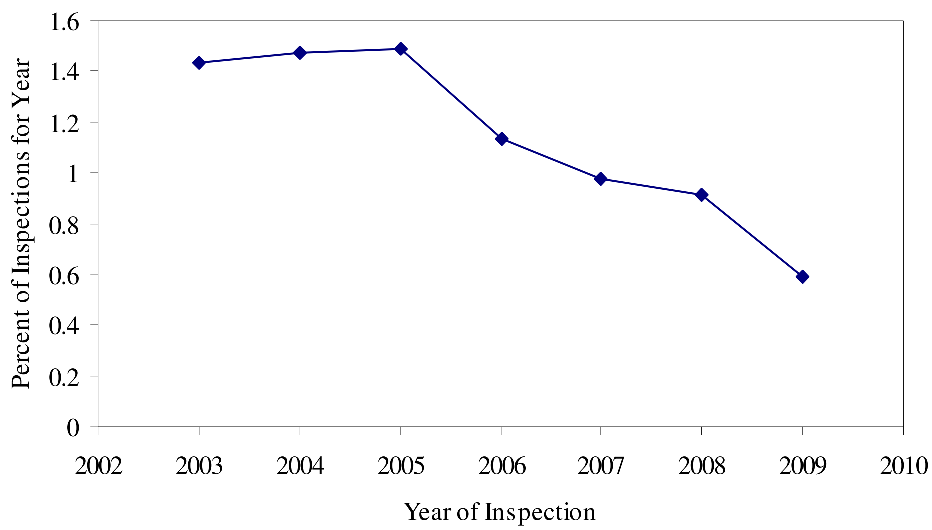


Table 5-20. Check Digit Error Percentage

Station ID	Inspector ID	Check Digit OK	Check Digit Error	Total	Check Digit Error %
2P35798	07001394	5049	7730	12779	60.5
1P38893	12307534	172	76	248	30.6
1P38336	00675308	619	247	866	28.5
2P35798	20391037	6396	2452	8848	27.7
1P39053	20513059	144	53	197	26.9
2P35798	26498183	2764	1016	3780	26.9
1P39062	12307534	498	167	665	25.1
1P37432	14567088	160	51	211	24.2
1P39272	01994602	155	48	203	23.6
2P35798	23521093	3123	955	4078	23.4
1P39309	26592781	321	93	414	22.5
1P39305	20513059	320	91	411	22.1
1P38554	26050206	96	27	123	22.0
1P35817	21205122	699	196	895	21.9
1P38336	24167605	138	38	176	21.6
1P39053	13995823	110	30	140	21.4
1P37811	20421195	151	39	190	20.5
1P32186	11527265	136	34	170	20.0
1P37415	25504463	405	101	506	20.0
1P32363	23605999	519	129	648	19.9

5.3 TIMS OBD Data Checks for Evidence of Station Fraud

"Clean-piping" is a term used to describe a type of vehicle tailpipe emissions test fraud in which an inspector substitutes a vehicle with passing emission rates in place of a vehicle with high emission rates in order to achieve a pass record for the high-emitting vehicle. Historically, this has been identified through the use of covert audits, notifications by motorists, and analysis of vehicle emission result trends. For a vehicle receiving an OBD inspection, the analogous practice is typically referred to as "clean-scanning," where a vehicle with no MIL illumination is substituted in place of a vehicle with MIL illumination and stored DTCs in an attempt to receive a passing test result. This type of inspector fraud may not only involve the use of another vehicle, but could also be performed with a handheld OBD simulator that is programmed with the vehicle's VIN (and possibly other PCM identifiers) and substituted in place of the vehicle. However, as described in Section 4 of this report, a number of test verifications are available to identify the use of OBD simulators, both real-time and through subsequent data analysis.

A more recent practice of OBD fraud involves use of a device called an OBD emulator, which is hidden in a vehicle and replaces the vehicle's OBD system with pre-programmed data.

This type of fraud is typically performed by motorists who have vehicles which may have been modified and wouldn't pass an OBD test. Via laptop, a motorist enters the vehicle's VIN, monitor support profile and readiness status, DTCs and MIL command status and possibly other PCM identifiers into the emulator. The emulator is placed in the vehicle, and the vehicle's DLC is removed and replaced with the emulator's DLC. The inspector performing the inspection generally doesn't even know that an emulator is being used. This type of fraud may also be identified (and prevented) using the same steps for identifying and preventing the use of OBD simulators and clean scanning, as described in Sections 4.1 through 4.4 of this report.

The four TIMS data checks that will be used in this section to identify potentially fraudulent inspections on a per-inspector basis are:

- Comparison of inspector-entered VIN to downloaded eVIN, intended to determine whether a different vehicle has been substituted for the inspection.
- Comparison of continuous monitor "supported/unsupported" on initial inspection to the vehicle's profile on retest inspection, again intended to determine whether a different vehicle has been substituted for the inspection.
- Identification of stations/inspectors with unusually high or unusually low inspection failure rates.
- Comparison of inspector-entered vehicle type (light duty vs. heavy duty) for initial inspection against vehicle type for retest inspection, to determine if vehicles are being switched to heavy duty type to avoid the more stringent light-duty inspection requirements.
- Comparison of time between failing initial inspection and passing retest inspection to identify retests that occur too quickly for repairs to have taken place in between.

Obviously, many inspectors/stations will have the occasional inspection where the VIN was accidentally entered incorrectly and didn't match the downloaded OBD VIN, the downloaded OBD VIN is incorrect (especially for pre-2005 vehicles) or an obvious quick repair was done and the vehicle successfully passed a retest soon after failing at initial inspection, etc. However, the goal of this section is to identify those stations where these events are frequent, suggesting that their occurrence is not accidental and these events are much more common than at other stations.

A percentile rank will be assigned to each station for its performance on each bullet the above list. Using a ranking of the stations for each measure permits the comparison of one measure to another measure even if the two have different types of results. The final result will be a compilation of the ranks for each station on each of the measures of intentionally falsely failing a vehicle or of falsely passing a vehicle. These compiled ranks will be discussed in Section 5.3.6.

5.3.1 Comparison of Manually-Entered VIN with Downloaded eVIN

For this analysis, the inspector-entered VIN for the vehicle was compared to the eVIN that was downloaded during the OBD inspection, to identify inspections where the OBD inspection was performed on a substitute vehicle. Test records from 2003 through 2009 were used to identify trends in the rate of VIN discrepancies, while test records from 2008 and 2009 were used to evaluate the rate of VIN discrepancies for individual stations and inspectors. Records with no OBD VIN present, or with "N/A", "OBSCURED", or less than 17 characters for the VIN were excluded. This reduced the dataset considerably: from 32 million records to 10 million records. For each of these remaining records, the OBD-downloaded VINs were compared with VINs entered (either via keyboard or barcode scan) during the vehicle inspection. Approximately 4% of these records (400,000 records) were found to have VIN to VIN discrepancies. An investigation of the rate of VIN discrepancies over the years of inspections, shown in Figure 5-4, revealed that almost all inspected vehicles from the early years of OBD (1996-1999) had VIN discrepancies. Rates were very low for the later model years, as was expected since the OBD VIN is frequently unreliable in non-CAN vehicles. As more vehicles have become CAN-compliant (full rollout by model year 2008), the OBD VIN has become a much more reliable indicator of fraud.

For Figure 5-5, the OBD inspection failure rate was calculated for inspections where a VIN mismatch was found (red symbols on plot), and again for inspections with no VIN mismatch (blue symbols on plot). Results for inspections performed in 2007, 2008, and 2009 are shown on the figure. It is clear that the failure rates were different for inspections with and without a VIN mismatch, but the differences are somewhat difficult to interpret, in particular without knowing whether the vehicles were CAN –equipped (and hence likely to have a valid e-VIN). For model years up to about 2003, the failure rate for vehicles with a VIN mismatch is lower than for vehicles with no VIN mismatch: this is what we expect for OBD clean-scanning. However, for 2004 and newer vehicles, the failure rate is actually slightly higher for inspections with a VIN mismatch than for inspections with no VIN mismatch, which is the opposite of clean-scanning. The reason for this is unclear. It is interesting to compare Figure 5-4 and 5-5: in Figure 5-4 we saw that almost all inspections of 1996-1998 and many inspections of 1999 vehicles included a VIN mismatch (as expected). These are the oldest OBD vehicles and therefore the most likely to fail the OBD inspection. However, Figure 5-5 shows us that the 1996-1998 vehicles had the very lowest OBD failure rates, lower than even the newest vehicles in the fleet. The high failure rate for the very newest vehicles has been seen in other state data and is believed to be due to a small sample size of non-standard tests, such as test-on-resale.

Figure 5-4. Rate of VIN discrepancies by Year of Inspection and Model Year

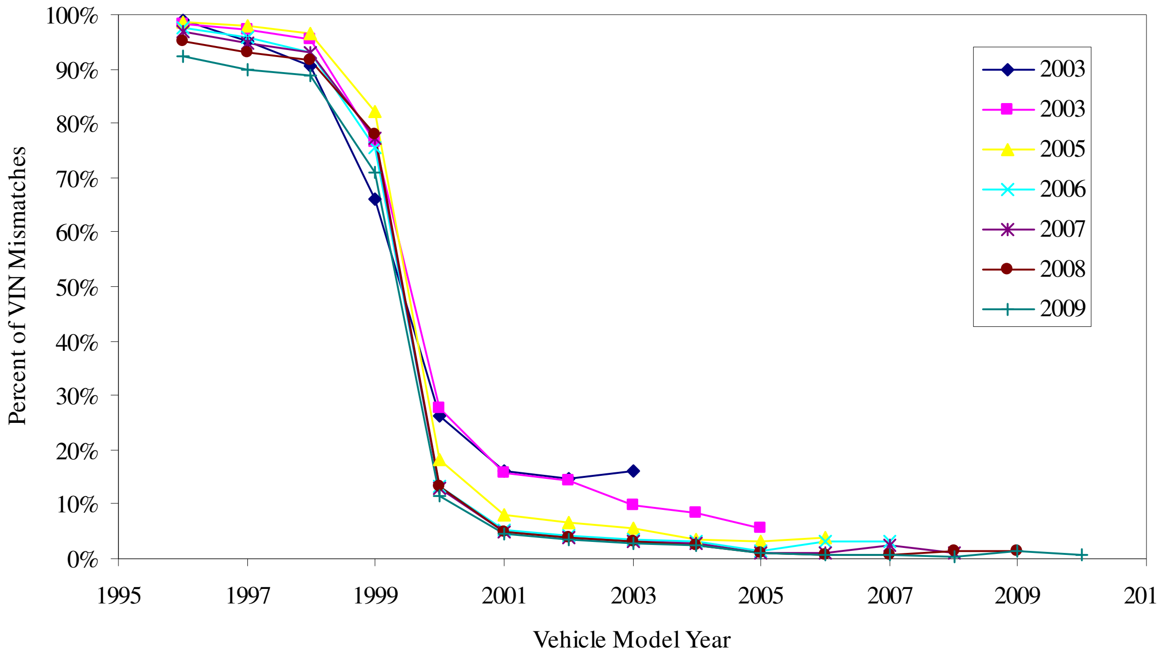
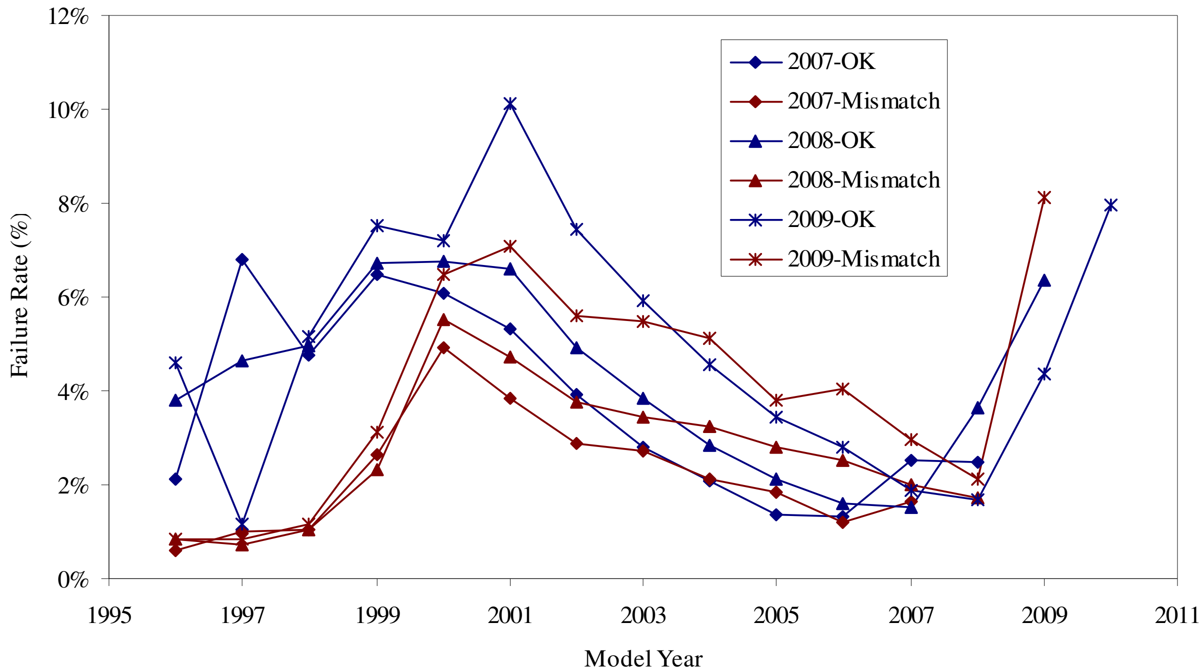
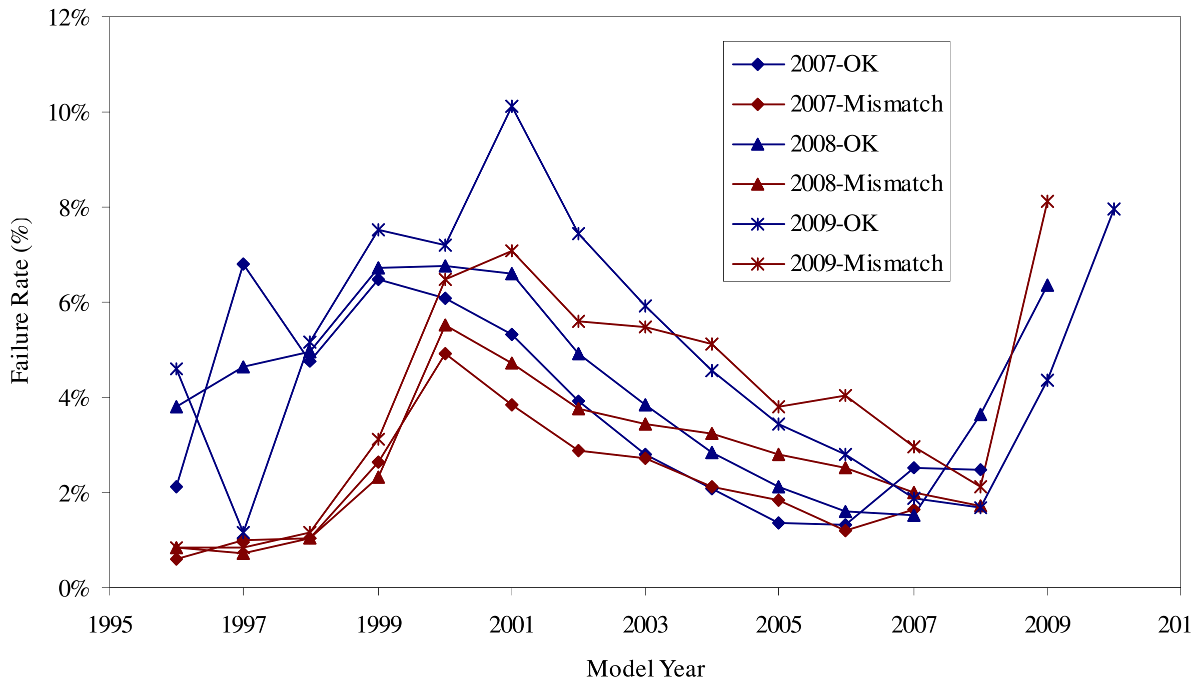


Figure 5-5. Inspection Failure Rate With and Without VIN Discrepancies



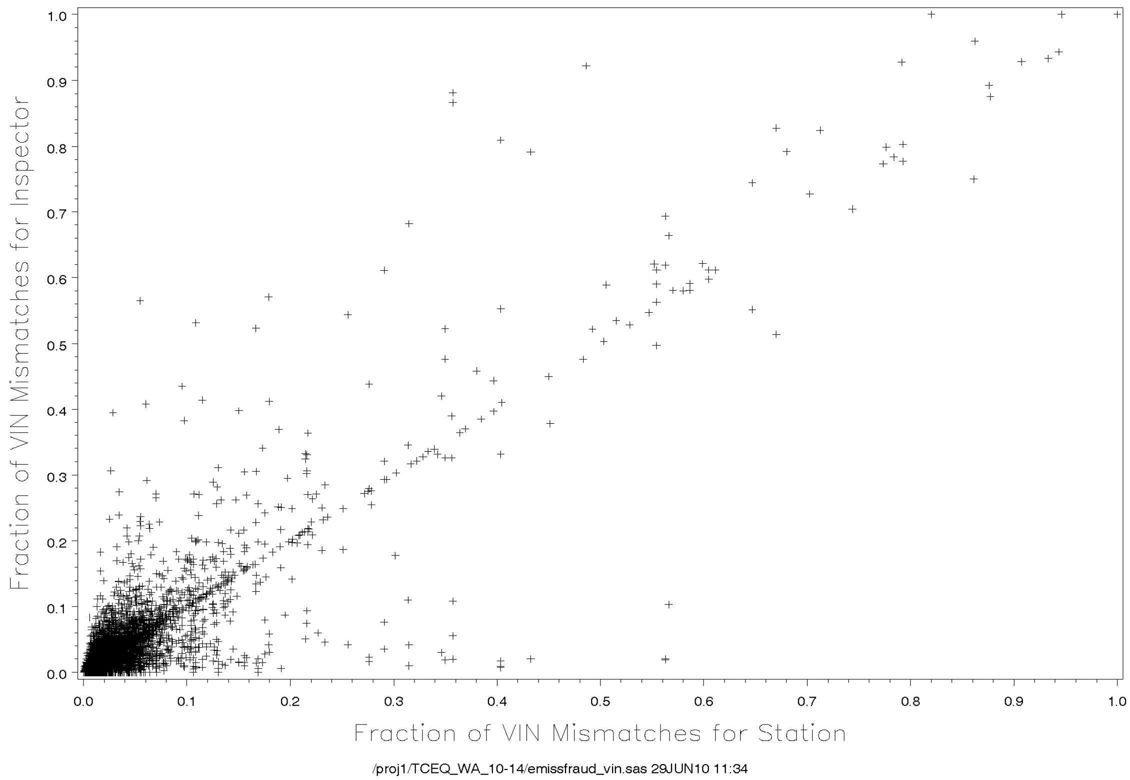
In Figure 5-6, the average model year for inspections where there was a VIN mismatch was compared to the average model year for inspections with no VIN mismatch. This figure shows that by 2009, the average vehicle with a VIN mismatch is several years older than the average vehicle with no VIN mismatch. In other words, it is the older vehicles that are receiving the VIN mismatch inspections, lending credence to the use of the VIN mismatches for identifying clean-scan inspections. However, as mentioned earlier, relatively few pre-MY05 vehicles were CAN-equipped, which could certainly contribute to a higher VIN mismatch rate in this segment of the fleet. (Approximately three percent (2.7%), of these records contain VIN discrepancies.)

Figure 5-6. Mean Model Year for Inspections with and without VIN Mismatches



As a first step, the rate at which discrepancies were recorded for each station that performed OBD inspections was calculated and then plotted against the rate of discrepancies for each inspector at that station. The results of this comparison are shown in Figure 5-7. The horizontal axis shows the fraction of OBD inspections that contained a VIN discrepancy for each station, while the vertical axis shows the fraction of OBD inspections with a VIN discrepancy for each inspector. To reduce noise/errors due to small sample size, stations or inspectors that performed fewer than 100 inspections were excluded from the plot. The large cluster of points at the bottom left corner of the plot includes most stations and inspections: these had a near-zero rate of VIN discrepancies. The points closer to 1 on the horizontal or vertical axis indicate stations or inspectors that almost always produced OBD records with a VIN discrepancy. Although these very-high rates could result from practices other than clean-scanning, such as consistently sloppy data entry, it seems unlikely because most stations are probably using barcode scanners to input the manual VIN entry as opposed to hand-entering the value. In any case, the stations or inspectors with very high rates would be good candidates for further investigation.

Figure 5-7. Rates of OBD-Downloaded and Inspector-Entered VIN Discrepancies, by Station and Inspector



One additional factor that was calculated for each station was the number of times the same VIN was downloaded in different OBD inspections. If clean-scanning is taking place, there is a good chance that the "clean" vehicle would be used repeatedly and its VIN would be downloaded numerous times, whereas VIN typos would vary with each inspection. This turned out to be a revealing investigation, as it was found that some stations did OBD inspections on the same downloaded-VIN more than a thousand times.

These VIN mismatch findings were condensed into a rank for each inspector and station, based on the fraction of inspections that revealed a disagreement between the entered VIN and the downloaded VIN. Stations or inspectors that performed fewer than 100 OBD inspections over the two year period were again excluded from the results, due to the possibility of spurious results from the small sample size. (By that we mean that the small sample sizes for these stations produce statistically noisy results that may not represent an actual trend for a given station, and may even be misleading.) As an example of the findings, the VIN mismatch rates for the 30 worst offending inspectors are listed below in Table 5-21, as well as the results for the corresponding station where the inspector works. The table shows the rate at which there was a disagreement between the entered VIN and the downloaded OBD VIN, out of all inspections that included a 17-digit VIN in both fields. It also shows the total number of inspections performed, and the maximum number of times a single VIN was tested.

The inspectors in the first five rows of the table actually had a mismatch rate of 100%, meaning all of their inspections had a VIN mismatch when both the OBD downloaded and the inspector entered VIN were present. For some of them, 100% of their inspections were on the same vehicle.

Table 5-21. Inspectors with Highest Rates of OBD and Entered VIN Mismatches

Station ID	Inspector ID	Percent of Inspections at Station Where VIN Did Not Match	Total Number of Inspections Performed at Station	Maximum Number of Tests on a Single VIN at Station	Percent of Inspections by Inspector Where VIN Did Not Match	Total Number of Inspections Performed by Inspector	Maximum Number of Tests by Inspector on a Single VIN
1P36597	10993195	100%	186	186	100%	186	186
1P37432	14567088	100%	105	48	100%	105	48
1P38443	27141199	95%	185	105	100%	104	96
1P39272	01994602	82%	545	219	100%	196	196
1P39272	23506001	82%	545	219	100%	226	218
1P37724	13995823	86%	196	170	96%	147	141
1P34167	13199492	94%	159	38	94%	159	38
1P36937	12577616	79%	523	81	93%	372	68
1P37411	26371918	91%	216	193	93%	195	179
2P36491	19102426	93%	300	83	93%	300	83
1P33344	20644360	49%	366	65	92%	180	65
1P33861	16598942	88%	959	810	89%	928	806
1P27736	17083412	88%	1352	211	88%	1282	198
1P37930	20644360	36%	1103	110	88%	143	79
1P37930	02614205	36%	1103	110	87%	261	68
1P36641	06718008	67%	3444	371	83%	1793	371
1P37557	24910744	71%	734	140	82%	598	137
1P18012	24215550	40%	1566	436	81%	688	436
1P35854	08421903	78%	179	14	80%	174	14
1P38159	18159992	79%	988	222	80%	593	174
1P37993	06988034	68%	341	27	79%	274	27
2P39199	20063303	43%	215	36	79%	115	36
1P38159	19540169	79%	988	222	78%	395	173
1P38878	21378920	78%	333	169	78%	310	166
1P36208	23873279	77%	773	389	77%	773	389
1P32363	22564230	86%	324	184	75%	124	65
1P38698	22564230	65%	286	61	74%	141	61
1P38422	24388755	70%	1640	398	73%	1538	394
1P37231	16670787	74%	410	114	70%	294	114
1P32094	15063014	56%	3862	1557	69%	2303	1557

Evaluation of the rate of VIN mismatches appears to be a fairly reliable way to identify stations that are performing clean-scanning OBD inspections, especially when applied to later model year CAN-equipped vehicles and when coupled with information about repeated inspections of the same vehicle.

In Section 5.1, we discussed the "triggers" available to DPS and TCEQ in order to identify stations that may be performing fraudulent inspections. In Table 5-1, the stations that were identified using the triggers as having a high rate of eVIN mismatches in 2007/2008 were listed. For the top 30 stations from that list, the 2009 TIMS data was used to calculate their most recent VIN mismatch rate. By 2009, 20 of the 30 stations were no longer performing I/M inspections. The results for the 10 stations that were still operating in 2009 are shown below in Table 5-22. The table shows that seven of these were still recording high rates of VIN mismatches, and also performing a large number of inspections on the same vehicle – strong indicators of OBD clean-scanning. It may be that additional investigation is warranted in order to confirm and eliminate clean-scanning occurring at these stations.

Table 5-22. 2009 Results for 2007/2008 eVIN Trigger Stations

Station ID	Percent of Inspections at Station Where VIN Did Not Match	Total Number of Inspections Performed at Station	Maximum Number of Tests on a Single VIN at Station
1P32363	95%	195	183
1P36641	71%	2160	371
1P37190	61%	530	317
1P32094	49%	1822	874
2P34869	49%	195	18
1P37414	33%	412	132
1P35240	29%	364	8
1P36998	7%	168	5
1P18012	3%	459	7
1P32181	1%	345	4

5.3.2. Change in Vehicle-Specific Downloaded Information from Initial to Retest Inspection

The purpose of this analysis was to compare OBD-downloaded information for a given vehicle on its first inspection to OBD-downloaded information on retests of that same vehicle. The use of supported monitor profiles for a make/model/MY family of vehicles and how it can be used to create unique "electronic profiles" for each vehicle was described in Section 4. Specifically, the electronic profile should be the same at the initial inspection and at subsequent inspections. If the electronic profile changes from one inspection to the next, inspection fraud may be suspected. The analysis in this section is somewhat different in that it uses the readiness profile of the vehicle during the initial test and compares it to the readiness profile during the retest.

For the yearly portion of this analysis, records from 2003-2009 were used, while for the station/inspector specific portion of this analysis, only vehicle inspection cycles from 2008 and 2009, were used. Only inspection cycles that included an initial inspection and at least one retest were used, reducing the yearly dataset from 32 million to 4 million records, and the 2008/2009 dataset to 1.5 million records.

Three variables were used to create the first "electronic profile" for each vehicle: the OBD-downloaded VIN, the PCM ID, and the PID count. Changes in communication protocol between the initial and subsequent re-tests could be used in a similar manner; however, it was not done in this study because we did not believe it would provide any improved fraud detection capability given the three parameters we have chosen for this first electronic profile. The downloaded values for these three variables from all OBD tests conducted over the multi-year period are summarized below:

- OBD VIN: OBD-downloaded VINs (valid or invalid) were only available in 34% of the test records. The OBD VIN or the test VIN (barcode or keyboard) was null in the remaining OBD test records. Because of this, use of the OBD VIN in itself would not be sufficient to positively identify clean-scanning.

- PCM Module ID: PCM Module ID was available in approximately 93% of the test records. Dozens of unique PCM Module IDs were seen, but 67% of all PCM Module IDs had a value of "10". Five other PCM Module IDs each comprised an additional 2 to 4% of the test records, and the remaining test records were distributed among the other PCM Module IDs. Because of this, as with the OBD VIN, use of PCM Module ID alone would not be sufficient to positively identify clean-scanning (a substituted vehicle could easily have a value of "10" or one of the other five common PCM Module IDs).

- PID count: 101 unique PID count values were seen, and approximately 95% of all OBD test records contained a value for PID count. Four PID count values were seen in 60% of all OBD test records, while the remaining test records contained one of the remaining 97 PID count values.

- When the PCM Module ID and PID count are looked at in combination, the three most common combinations comprise 14, 12, and 11% of the inspections, an additional seven combinations each comprise 1% to 10% of the inspections, and another 1400 combinations make up the remainder of the inspections. Thus the combination of PCM Module ID and PID count is highly variable and may be a good indicator of a different vehicle being substituted for the test.

The second electronic profile that was created was a "supported profile". For this, OBD monitors were identified that are commonly found to be both "monitored" and "not monitored" (i.e. "supported" and "not supported") depending on the make/model/model year of vehicle being inspected. For example, very few vehicles have monitored positive crankcase ventilation or air conditioning systems, so these would be poor indicators of potential clean-scanning since the monitored status is almost surely the same for two different vehicles. Similarly, catalysts and oxygen sensors are almost always monitored, so these too would be poor indicators of potential clean-scanning. Again, two different vehicles will likely both have these monitored. As shown below, EGR systems, evap systems, and to a lesser extent heated oxygen sensor systems and secondary air injection systems were seen to have significant percentages of vehicles with both "monitored" and "not monitored" status:

- EGR systems: 33% not monitored, 67% monitored
- evap systems: 15% not monitored, 85% monitored
- heated O2 systems: 2% not monitored, 98% monitored
- secondary air systems: 93% not monitored, 7% monitored
- When the status of the four monitors is looked at together, two combinations of monitor status dominated the dataset, with 52% and 25% of vehicles. Smaller numbers of vehicles comprised the remaining 14 combinations and 23% of vehicles. Since the combined monitored status of these four monitors could provide a distinguishing and characteristic profile from vehicle to vehicle, these four monitors were used for this analysis.

An electronic profile and a monitored-status profile were created for each vehicle, for its initial inspection and for any re-inspections. Any tests where either profile differed from inspection to inspection were flagged. Tests where both the electronic profile and the monitored-status profiles changed would be an indicator that a different vehicle was being substituted for the test. Note that for any individual vehicle, these downloaded values may vary among analyzer manufacturers (in particular the PCM Module ID and the PID Count), so the analysis was based on vehicle/analyzer combinations. All inspections where the initial inspection took place on a different type of analyzer than that used for the retest inspection were excluded from the analysis.

Occasionally, analyzer hardware upgrades or software updates could result in OBD system PID count mismatches between multiple tests on the same vehicle, and the OBD-downloaded VIN could be mismatched on multiple tests from the same vehicle in extremely rare instances where the PCM on the vehicle was improperly reprogrammed in an attempt to repair the vehicle. An assessment of the likelihood of fraud is provided for each of the scenarios listed below. It is also worthwhile to note that since each vehicle's OBD system "profile" was assigned based on the information collected during the vehicle's first test, this analysis would not identify any tests where a vehicle was substituted, i.e., clean-scanned, during the initial inspection.

As described above, the yearly dataset included 4 million total inspections, of which 1.93 million were retests. Of those retests, about 300,000 took place on a different type of analyzer than that of the initial test, and were excluded from the results. This left 1.90 million retests for analysis of the 2003-2009 data. The statewide rate of mismatches for the electronic profile, by year of inspection and vehicle model year, is shown in Figure 5-8. This figure shows that the rate of electronic profile mismatches decreased dramatically for the most recent year of inspections (2009). The statewide rate of mismatches of both the electronic profile and the supported monitor profile is shown in Figure 5-9; the large improvement for 2009 is not seen in this figure: the 2009 results are similar to the results for the other years of inspections.

Figure 5-8. Statewide Rate of Electronic Profile Mismatches

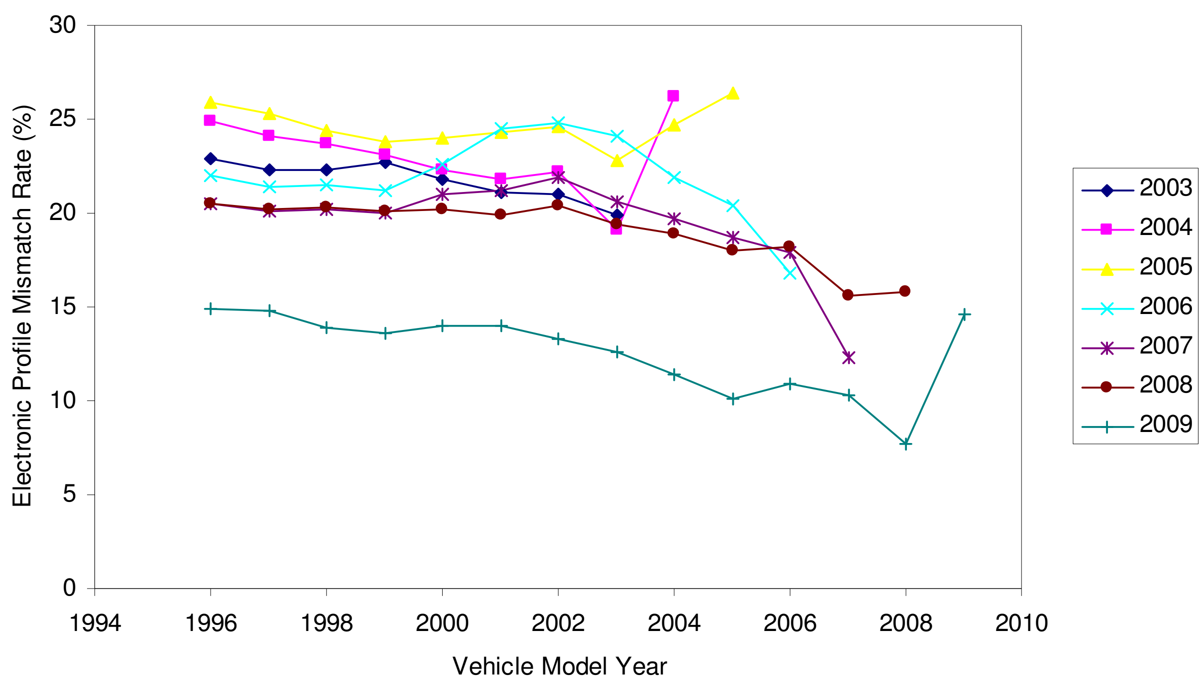
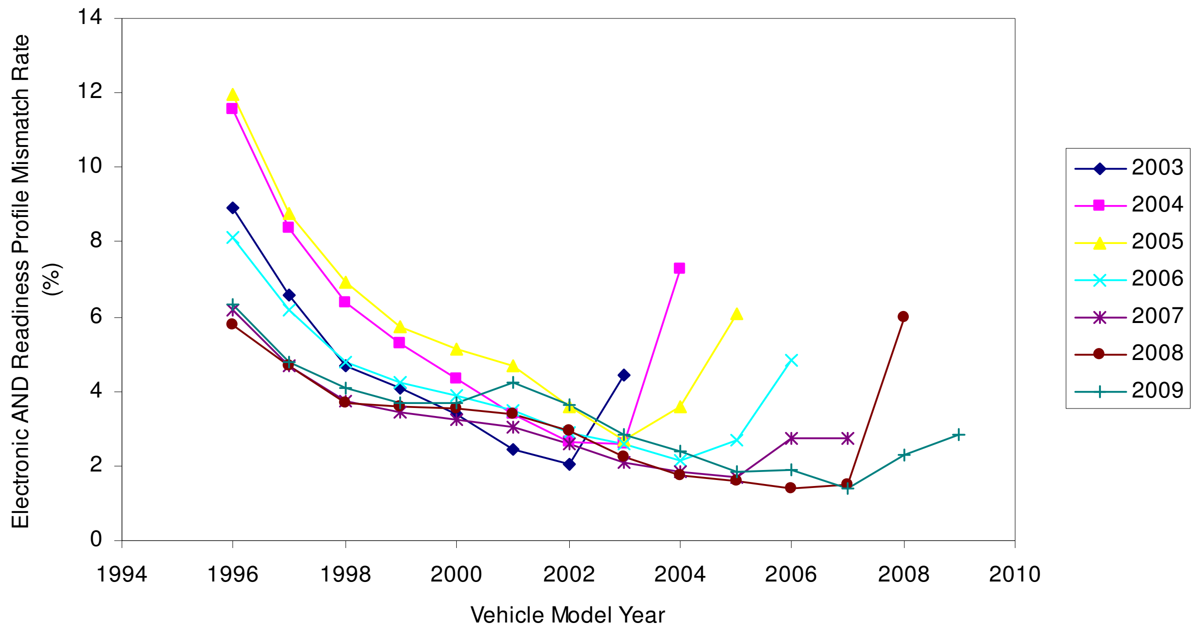


Figure 5-9. Statewide Rate of Electronic and Supported Monitor Profile Mismatches



For the most recent two-year period of 2008-2009, a more detailed analysis of rates of electronic profile and supported monitor profile mismatches was performed on a station/inspector basis. For those two years, 713,594 retest inspections were available. The results were:

- 83.7% of tests had matches for both the electronic profile and the supported monitor profile between initial test and subsequent retests on the same analyzer. These tests very likely indicate compliant testing.

- 3.3% of tests had a mismatch for both the electronic profile info and the supported monitor profile, between the initial test and at least one retest on the same analyzer. Test pairs where both PCM ID (and PID count) information and readiness profile differ are likely to be performed on two different vehicles (i.e., an indication of clean-scanning).

- 12.6% of tests had an electronic profile mismatch between the initial test and at least one retest on the same analyzer, but the "supported monitor profile" matched between the initial test and all subsequent retests on the same analyzer. Since the PCM ID (and PID count) serves as a unique identifier for any vehicle, this information should always match for retests on the same vehicle. A mismatch could occur only in the following scenarios:

    - if another vehicle was substituted for a retest (clean-scanning)

- if an anomaly in the analyzer software interpreted the PID count info two different ways on subsequent retests for the same vehicle
- if a vehicle repair was performed in which the vehicle's PCM was re-programmed with new ID info as a part of a repair

- Although the last two scenarios are unlikely, it was not possible to quantify the likelihood of this occurring in this analysis. It is possible for two different vehicles to have common supported monitor profiles, so a supported monitor profile match does not confirm that clean-scanning did not occur. Therefore, this scenario (PCM ID and PID count mismatch) is felt to be a good indicator of clean-scanning.

- 0.3% of tests had a "supported monitor profile" mismatch between the initial test and at least one retest on the same analyzer, but the electronic profile matched between the initial test and all subsequent retests on the same analyzer. This scenario is difficult to interpret, since the supported monitor profile is based on "monitored vs. unmonitored" status of various systems, as opposed to ready/not ready status, and therefore should never change for a vehicle despite the vehicle's state of readiness. Similarly, the PCM ID and PID count information should be static for any one vehicle except for the case when PCM reprogramming is part of the repair process. Because of the contradictory results, the scenario of a supported monitor profile mismatch with a PCM ID and PID count match is not considered to be a strong indicator of non-compliant testing.

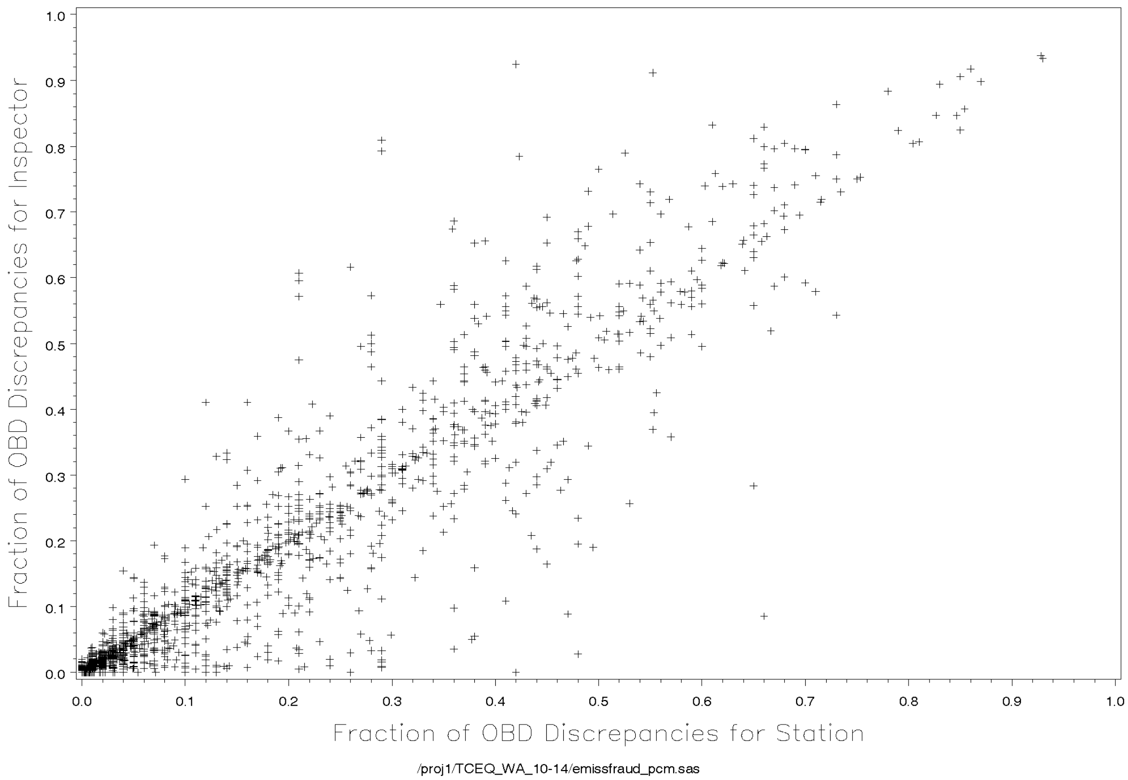
A summary of this information is provided in Table 5-23.

Table 5-23. Percentages of Tests with Various OBD Fraud Indicators

Retest Match Scenario	Retest-only Dataset (713,594 tests total)
All match (compliant)	83.7 %
Readiness mismatch (ambiguous)	0.3 %
PCM ID info mismatch (fraud likely)	12.6 %
Both mismatch (fraud very likely)	3.3 %
Estimated % of clean-scanning	4% to 16%

The distribution of station and inspector mismatch rates is shown in Figure 5-10. The horizontal axis shows the fraction of retest records that contained an electronic profile or supported monitor profile mismatch, for each station. The vertical axis shows the fraction for each inspector. The large concentration of data points in the lower left corner are stations and inspectors that produced retest records that rarely had a mismatch when compared to the information from the initial inspection. In contrast, the stations/inspectors in the upper right-hand portion of the chart are those that are most likely to be clean-scanning.

Figure 5-10. Rates of Re-Test Discrepancies in OBD ID and Supported Monitor Information, by Station and Inspector



These results were condensed into a rank for each station, based on the fraction of retest inspections performed at that station that included both an electronic profile mismatch and a supported monitor profile mismatch. Stations with fewer than 100 OBD retest inspections over the two year period were excluded from the results, due to the possibility of spurious results from the small sample size. The 20 inspectors with the highest rates of profile mismatches are listed in Table 5-24. Some electronic profile and/or supported monitor mismatches are to be expected, and most stations had at least one case of a mismatch. However, most stations had only one or a few mismatches. Overall, about 3.3% of retest inspections resulted in a supported monitor profile and electronic profile mismatch. When stations with a mismatch rate several times higher than 3.3% are seen, one can start to suspect that something beyond the expected occasional difference is taking place. As an additional consideration, the table includes the failure rate for inspections where a mismatch was found and the failure rate for inspections where there was not a mismatch. In most cases, the failure rate was much lower for the mismatch inspections, adding weight to the hypothesis that the mismatch is the result of clean-scanning.

Table 5-24. Inspectors with Highest Percentage of Electronic Profile and Supported Monitor Profile Mismatches

Station ID	Inspector ID	Percent of Re-inspections with BOTH Electronic & Supported Monitor Mismatch	Percent of Re-Inspections with Electronic OR Supported Monitor Mismatch	Number of Re-inspections at Station	Fail % for Mismatch Inspections	Fail % for No-Mismatch Inspections
2P36721	04047729	73%	86%	251	0%	6%
2P30412	11984564	72%	91%	106	0%	0%
2P30412	15095569	68%	82%	268	0%	4%
1P38422	24388755	66%	92%	182	1%	0%
1P36419	24901515	61%	75%	166	0%	22%
1P38849	21931301	60%	75%	176	0%	5%
2P38458	02813681	60%	76%	116	0%	29%
1P36809	23634757	58%	90%	118	0%	0%
1P33507	11420689	55%	68%	146	1%	9%
2P31289	05210482	55%	94%	192	0%	0%
1P09343	1468231	54%	81%	202	5%	32%
1P36641	16109445	54%	81%	150	3%	14%
1P35608	12359955	53%	73%	356	0%	10%
2P38077	21289572	52%	80%	177	0%	11%
1P28538	15177092	51%	79%	100	0%	10%
1P34773	24388755	51%	92%	106	1%	0%
2P31289	05730674	50%	93%	270	0%	0%
2P35060	14471300	48%	83%	149	2%	20%
1P34501	05799861	47%	62%	119	1%	11%
1P35540	04810102	47%	61%	231	9%	18%

5.3.3 Pass/Fail Outliers

Stations can also be evaluated based upon the percentage of vehicles that they pass or fail. Extremely high rates of either passing or failing vehicles may warrant further scrutiny. It is recognized that differences in inspection failure rates among stations are often due to factors other than fraud. For instance, the age and maintenance level of the fleet tested at each station may vary widely. However, evaluation of the fleet quality and/or socio-economic status of the area each station is beyond the scope of this evaluation, and only overall pass/fail rates for each station are considered here.

To identify individual stations/inspectors with outlying pass/fail rates, the most recent two years' of data were used (2008-2009). Since it was necessary to identify both very low and very high failure rates, the stations were divided into two groups: stations with a failure rate that was above the mean failure rate over all stations, and stations with a failure rate that was below the mean failure rate over all stations. Each station is included in only one of the groups. The highest failure rate stations are listed in Table 5-25. The lowest failure rate stations are listed in Table 5-26. Stations with fewer than 100 inspections are excluded from the results.

Table 5-25. Stations with Highest Failure Rates

Station ID	Inspector ID	Failure Rate	Number of Failed Inspections	Total Number of Inspections
1P38769	8574492	43.7	118	270
1P39915	3056537	38.4	78	203
1G20021	14737327	33.3	36	108
2P35060	18499588	30.0	54	180
1P38476	19172233	29.2	42	144
1P40050	18914043	28.2	33	117
1P39429	26793435	26.9	45	167
1P36982	28332836	26.8	64	239
1P38854	10138900	26.7	35	131
1P37961	20052905	26.7	122	457
2P32154	12352408	26.2	481	1838
1P36982	12271383	25.7	138	537
2P32154	16562171	24.7	127	514
2P39501	16154951	24.6	70	284
1P39107	23452484	24.5	26	106
1P39670	22736673	23.8	36	151
1P39928	6931981	23.7	148	625
1P37446	12756222	23.6	281	1189
6P34288	6838249	23.5	166	705
1P37983	7824490	23.1	30	130

Table 5-26. Stations with Lowest Failure Rates

Station ID	Inspector ID	Failure Rate	Number of Failed Inspections	Total Number of Inspections
1F22216	12692086	0	0	183
1F33455	13870073	0	0	108
1P00199	8303183	0	0	137
1P00545	15902376	0	0	302
1P03546	18646022	0	0	121
1P04152	18285336	0	0	123
1P04198	18451356	0	0	173
1P04198	20730641	0	0	111
1P05638	9572836	0	0	377
1P07522	10100852	0	0	242
1P10509	17188960	0	0	243
1P11707	1736400	0	0	189
1P11707	8830973	0	0	296
1P11707	11603412	0	0	111
1P11707	18007483	0	0	101
1P11904	20730641	0	0	123
1P17346	7104148	0	0	113
1P17346	18206521	0	0	145
1P17358	2894777	0	0	110
1P17358	22663218	0	0	104

5.3.4 Change of Vehicle from Light Duty to Heavy Duty

Given that inspection standards are generally less stringent for heavy-duty vehicles than for light-duty vehicles, ERG investigated whether switching a vehicle from having a light-duty GVWR (less than 8,500 lbs) to a heavy-duty GVWR was ever used to manipulate emissions inspection results. The vehicle GVWR is an inspector-entered field in the inspection record. For this analysis, only inspection cycles where the initial inspection and the retest inspection were conducted at the same station by the same inspector and within a 14-day period were used. This left 485,000 retest inspections in the dataset.

Overall, it was found that only 0.2% of inspections that were initially failed as a light-duty vehicle were followed by a passing retest as a heavy-duty vehicle. However, these inspections were clustered at a handful of stations, shown below in Table 5-27. The table shows the twenty I/M inspectors with the highest frequency of retests that involved a vehicle that failed as a light-duty vehicle on the initial inspection, followed by a passed retest of the same vehicle as a heavy-duty vehicle. The VIN/station/inspector combination were specifically tracked and matched for this analysis. To ensure this result was not a function of analyzer equipment, the results were broken out by analyzer manufacturer and 634 occurrences were found for ES analyzers, 2 for JB, 85 for SE and 197 for WW. For the first inspector on the list, fully 27.5% of vehicles that failed as a light-duty vehicle were switched to a heavy-duty vehicle, and passed.

5.3.5 Retest Inspection Following Initial Inspection Too Closely

For inspection cycles that begin with a failing inspection, a retest (or retests) usually follows a day or several days after the initial failed inspection. Presumably, repairs are performed during that interval between inspections. However, some failing inspections are followed by a passing inspection within minutes, leading one to wonder how the vehicle was successfully repaired so quickly, or if instead clean-piping (or clean-scanning) occurred for the passing retest. The dataset shows that many stations have one or a few cases of a passing retest following a failing initial test within a short time. These occasional cases may be the real result of a simple fix: a vehicle warm-up, a reconnection of a loose line or wire or some other simple change. Some vehicles which failed with emissions levels very near the cutpoints might also be retested after no repairs, and pass due to I/M test variability. However, some stations show a much more frequent occurrence of initial inspections being quickly followed by passing inspections when compared to the majority of stations. In these cases, there may be cause for a suspicion of inspection fraud.

Table 5-27. Percent of Retest Inspections Switched from Light-Duty to Heavy-Duty, for 20 Worst Stations

Station ID	Inspector ID	Percent of Retests Switched from LD to HD	Number of Switched Retests	Total Number of Retest Inspections
2P12339	14308569	27.5	47	171
1P35240	6526673	13.1	17	130
1P06692	6421909	12.0	12	100
2P27092	9246011	10.1	23	227
2P35970	17466067	9.6	20	208
2P27451	21280922	8.6	14	162
1P38060	17304472	5.4	6	112
2P33265	8046913	5.1	14	273
2P38578	7456057	5.1	6	118
1P38872	48201	4.9	7	143
1P11892	12344460	4.2	5	118
1P37108	20118794	4.0	7	176
2P35722	22316253	3.7	5	134
2P29619	20486152	3.7	10	271
2P33032	1580352	3.6	22	611
2P36226	17501907	3.2	7	219
1P33944	14400218	3.1	11	355
1P25057	11956724	3.0	3	100
1P00516	16452330	3.0	5	169
2P34724	17318085	2.9	5	173

For this analysis, only time differences on retest inspections that were conducted in 2008/2009 at the same inspection station by the same inspector as the initial inspection were used. This resulted in a dataset of about 511,000 retest observations. The data field used in this analysis was TX96_OBD2_PF_FL with records having an “F” followed by a “P” within 20 minutes having the same vehicle/station/inspector flagged as suspicious.

The distribution of the number of times that a failed initial inspection was followed by a passing retest within 20 minutes by a given inspector over a 2 year period is listed in Table 5-28. The table shows that this happened 84 times by the inspector with the highest frequency of occurrences, while for most of the 20,000 inspectors that performed tailpipe inspections, it did not ever happen.

The twenty inspectors with the highest rate of close-in-time retests are listed in Table 5-29. The percentage was calculated from the number of close-in-time retests and the total number of retests, by that inspector. Inspectors that performed fewer than 100 retest inspections over the 2 year period are excluded from the results. A visual inspection of the records for the station in the second and third lines of the list, 1P38108, shows that the passing inspections that closely follow a failing inspection are frequently for a different eVIN (the downloaded OBD VIN) – clearly clean-scanning.

Table 5-28. Number of Close-in-Time Retests per Inspector

Number of Close-In-Time Retests	Number of Stations	Percent of Stations
0	14090	70.2
1	3671	18.3
2	1143	5.7
3	505	2.5
4	268	1.3
5	133	0.7
6	59	0.3
7	50	0.2
8	31	0.2
9	31	0.2
10	16	0.1
11	13	0.1
12	6	0.0
13	7	0.0
14	4	0.0
15	5	0.0
16	5	0.0
17	2	0.0
18	5	0.0
20	3	0.0
21	2	0.0
22	2	0.0
24	2	0.0
29	2	0.0
32	1	0.0
39	1	0.0
49	1	0.0
50	1	0.0
84	1	0.0
Total	**20,060**	**100.0**

Table 5-29. Percent of Close-In-Time Retest Inspections for 20 Worst Inspectors

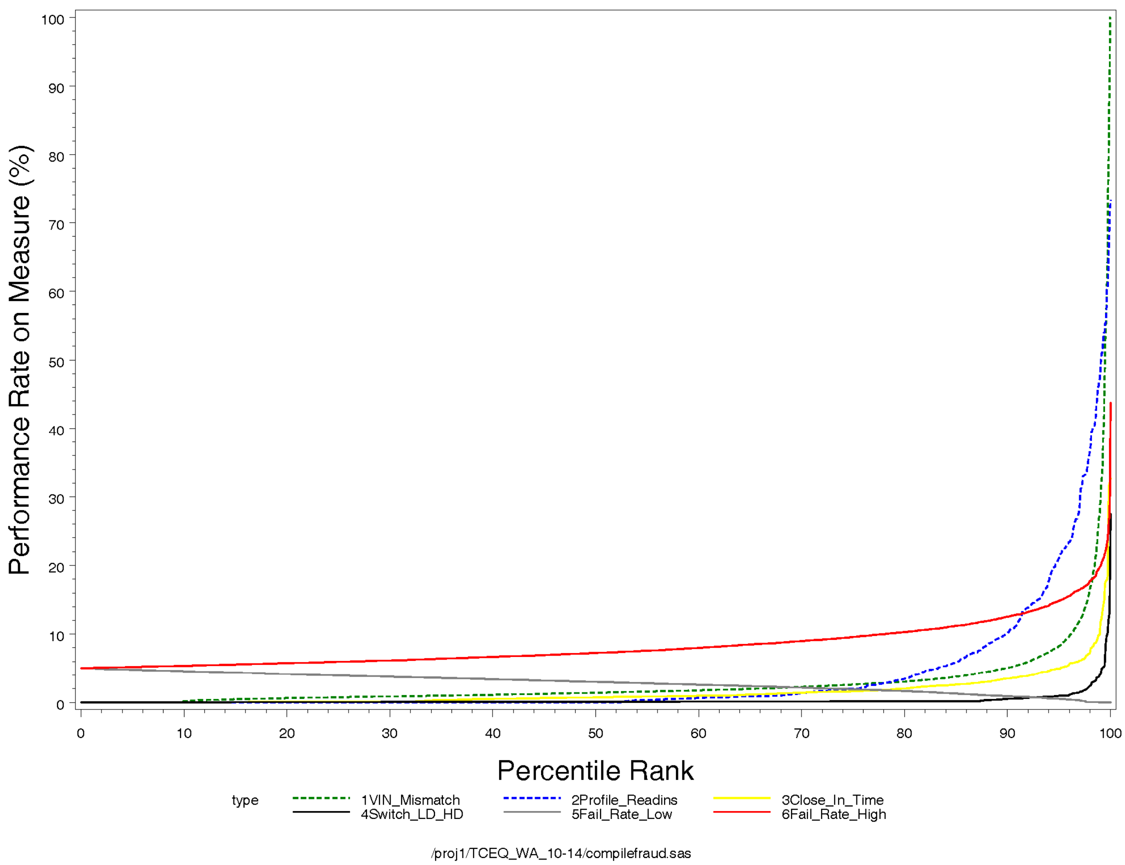
Station ID	Inspector ID	Percent of Retests that were Close-In-Time	Number of Close-In-Time Retests	Total Number of Retest Inspections
1P38422	24388755	32.7	49	150
1P38108	15215154	31.9	84	263
1P38108	13267446	31.5	39	124
1P00516	16452330	18.4	32	174
1P35322	25175587	17.8	18	101
1P38236	13937326	17.8	24	135
1P36823	19182404	17.4	24	138
2P37904	14648415	14.9	50	335
2P12814	5393780	14.0	15	107
2P18990	23420131	13.2	15	114
2P38602	14598397	12.3	22	179
1P37108	20118794	11.7	18	154
1P37140	19182404	9.9	11	111
2P34709	24622333	9.9	14	142
1P34403	17304472	9.5	12	126
1P31462	9950741	9.1	13	143
2P34222	17416457	8.7	22	252
6P32472	13355610	8.7	9	104
2P12191	15513884	8.6	10	116
1P37243	25447079	8.2	16	194

5.3.6 Compilation of the Five OBD Fraud Indicators from TIMS Results

After a separate ranking was assigned for each of the measures of potential fraud, the ranks were used to score and identify the stations with the highest likelihood of having performed fraudulent inspections

Some of the details of the ranking procedure and the resulting ranks make it challenging to combine the ranks for an overall score. First, most inspectors did not perform enough inspections of one type or another (i.e., OBD retests) to receive a rank for all of the measures. Secondly, it is known from the measures listed in the previous sections that the range of results was not the same for each measure. For example, for the OBD VIN mismatch section, about 75% of inspectors had very low VIN mismatch rates (near zero), while the remaining 25% had increasingly higher VIN mismatch rates. In contrast, for the OBD vehicle being switched from light-duty to heavy-duty in order to pass, at least 95% of stations had reasonably low rates of switching, and only the top 5% of stations would lead one to suspect possible fraud. Figure 5-11 below shows the distribution of the results and the rankings that were created from those results for each of the measures of errors of potential OBD clean-scanning (from sub-sections 5.3.1 through 5.3.5).

Figure 5-11. Distribution of Results and Percentiles for OBD Clean-Piping



The green and blue dashed lines for the VIN/eVIN mismatch and supported monitor/electronic profile mismatch show that the inspectors from 0 to the 75th percentile had a very low percentage of mismatches. Above the 75th percentile, the mismatch rate quickly increases. If a "cutpoint" were to be assigned, above which fraud is very likely, the 95th percentile would be a conservative choice for the VIN/eVIN mismatch, while the 90th percentile would be a conservative choice for the supported monitor/electronic profile mismatch. For the yellow and black lines showing the rate of overly close-in-time inspections and retests switched from light-duty to heavy-duty, the stations below the 95th percentile had very low results. Above the 95th percentile, the rate of potentially fraudulent results rapidly increases, and a conservative cutpoint could be set at the 98th percentile. The red and gray lines show the rankings for OBD inspection failure rates. For both of those lines, the 0th percentile is the mean failure rate over all stations. The percentiles for the red line increase as the failure rate increases further above the mean, while the percentiles for the gray line increase as the failure rate decreases further below the mean. For both of these, one sees a "break" at about the 90th percentile, where the OBD fail rate starts to change rapidly as the percentile continues to increase, and a conservative cutpoint could be set at the 95th percentile.

At percentiles below the "break" (the percentile above which the results rapidly worsen) in each line on Figure 5-11, it is not likely that the inspector is performing that type of fraudulent activity. As percentiles increase above the break, there is increasing evidence for suspicion of fraud. At percentiles above the "cutpoints" described in the paragraph above, fraudulent OBD inspections are very likely. To compile a list of the inspectors most likely to be performing any type of fraudulent OBD inspection, inspectors above the cutpoint for the given measure were flagged. Then, the total number of flags that each inspector received was determined. The list of all inspectors was then sorted by the descending number of flags received, in order to create a final list in order of most-suspicious to least-suspicious. The results for the top 50 most suspicious inspectors are given in Table 5-30.

The 50 inspectors listed in Table 5-30 each have at least one type of OBD fraud for which they were above the 99^{th} percentile, as did an additional 200 other inspectors that are not included on the table. Many others had a percentile in the high 90's for at least one type of OBD fraud, above the cutpoints described above. Any inspector with any rank above the cutpoint for one or more types of fraud is a good candidate for investigation (if they haven't already been, as a result of triggers or other audits). Again, the cutpoints that were used above were: 95% for VIN/eVIN mismatch, 90% for supported monitor & electronic profile mismatch, 98% for light duty to heavy duty switches, 98% for close-in-time retests, and 95% for high above the mean and low below the mean failure rates.

Table 5-30 is a sample of the results for the 50 inspectors with the most suspicious results; the entire table with all inspectors is available in electronic format.

5.3.7 Discussion of Impact of Fraudulent OBD Inspections on Overall I/M Program

For an I/M program to function as it was designed to, it is critical that each I/M inspection station and inspector follow the procedures and regulations that have been created to ensure that inspections are consistently performed properly. If they are not, particularly in the case of clean-piping or clean-scanning, some of the emissions benefit that should be achieved by an I/M program will be lost.

In Sections 5.3.1 through 5.3.5, various methods of identifying OBD inspection fraud were investigated, and while clean-scanning was quite common for some stations, the total fraction of OBD inspections that were fraudulent appears to be very small relative to the overall number of OBD inspections. Using the 2008/2009 dataset, the percentage of all inspections that involved OBD fraud are listed in Table 5-31. The number of inspections used for the calculation

Table 5-30. Top 50 Most Suspicious Stations for OBD Clean-Scanning

Station ID	Inspector ID	Sum of Rank Flags	Max Rank for Station	Individual Ranks					
				OBD VIN Mismatch	OBD Profile/ Supported Monitor	Close-In-Time Retest	Switch LD to HD	Low Fail Rate	High Fail Rate
1P38422	24388755	3	100.0	99.8	99.8	100.0	0.0	61.7	.
1P38108	15215154	3	99.9	98.8	97.8	99.9	0.0	.	3.2
1P35240	06526673	3	99.9	99.4	97.1	57.2	99.9	.	80.8
1P38108	13267446	3	99.8	98.3	97.0	99.8	0.0	.	43.4
1P00516	16452330	3	99.7	92.7	93.3	99.7	98.3	.	7.6
1P35322	25175587	3	99.6	98.5	97.9	99.6	95.9	.	78.5
2P33265	08046913	3	99.3	48.8	91.1	95.0	99.3	.	95.3
2P18990	23420131	3	99.2	97.3	96.2	99.2	0.0	.	89.3
1P35918	03504928	3	99.1	99.1	91.9	71.0	0.0	.	98.3
1P37961	13225105	3	98.8	98.8	96.5	0.0	0.0	.	96.9
1P34403	17304472	3	98.8	97.6	97.7	98.8	93.6	.	38.1
1P00755	07842191	3	98.7	96.1	91.1	0.0	0.0	.	98.7
1P31462	09950741	3	98.7	98.2	97.6	98.7	0.0	.	53.3
6P32472	13355610	3	98.5	96.7	96.8	98.5	.	.	56.7
2P12191	15513884	3	98.4	97.3	92.9	98.4	0.0	52.6	.
2P30774	20084221	3	98.3	95.2	98.3	41.3	0.0	.	98.1
1P39272	23506001	2	100.0	100.0	.	.	.	97.1	.
1P39272	01994602	2	100.0	100.0	.	.	.	95.2	.
1P37432	14567088	2	100.0	100.0	.	.	.	99.0	.
1P37724	13995823	2	100.0	100.0	.	.	.	99.0	.
2P30412	11984564	2	99.9	68.2	99.9	.	.	96.7	.
1P37411	26371918	2	99.9	99.9	.	.	.	99.0	.
2P30412	15095569	2	99.9	47.6	99.9	.	.	96.5	.
1P37557	24910744	2	99.9	99.9	98.4	.	.	58.8	.
1P18012	24215550	2	99.8	99.8	98.1	0.0	0.0	.	53.1
1P38159	18159992	2	99.8	99.8	97.7	.	.	80.6	.
2P33282	19704152	2	99.8	97.8	.	.	.	99.8	.
1P37231	16670787	2	99.7	99.7	94.5	50.3	0.0	34.4	.
1P32094	15063014	2	99.7	99.7	.	.	.	95.5	.
1P35091	22023491	2	99.7	99.7	.	.	.	96.9	.
1P37414	10916220	2	99.7	99.7	.	.	.	97.3	.
1P35639	00221705	2	99.7	99.7	93.8	0.0	0.0	9.9	.

Table 5-30. Continued

Station ID	Inspector ID	Sum of Rank Flags	Max Rank for Station	Individual Ranks					
				OBD VIN Mismatch	OBD Profile/ Supported Monitor	Close-In- Time Retest	Switch LD to HD	Low Fail Rate	High Fail Rate
1P36809	23634757	2	99.6	.	99.6	.	.	97.7	.
1P37414	22431061	2	99.6	99.6	.	.	.	95.7	.
1P38236	13937326	2	99.6	94.3	96.3	99.6	0.0	.	38.7
2P31289	05210482	2	99.5	78.6	99.5	.	.	96.5	.
1P36823	19182404	2	99.5	95.6	86.5	99.5	0.0	.	72.9
1P36641	16109445	2	99.5	99.5	99.4	.	.	81.1	.
1P38060	17304472	2	99.4	98.6	81.0	91.4	99.4	.	83.0
1P35690	15047053	2	99.4	99.4	97.5	94.9	0.0	.	37.1
1P28538	15177092	2	99.4	99.4	99.2	96.2	.	53.1	.
2P37904	14648415	2	99.4	29.0	95.7	99.4	0.0	35.7	.
1P31791	01841166	2	99.4	99.4	96.5	.	.	5.1	.
1P35608	12359955	2	99.3	97.4	99.3	34.0	0.0	.	29.2
1P37182	18236360	2	99.3	99.3	.	.	.	97.0	.
1P36998	25007900	2	99.3	99.3	96.6	76.0	0.0	78.8	.
1P32402	09170938	2	99.2	99.1	.	.	.	.	99.2
1P28329	06883517	2	99.2	99.2	98.5	.	.	38.4	.
1P30749	07241333	2	99.2	99.2	97.6	91.3	0.0	.	22.9
1P35918	17198443	2	99.2	99.2	.	.	.	.	98.1

Table 5-31. Percentage of Inspections Exhibiting OBD Fraud by Type of Analysis

Type of Clean-Scanning	No. of Inspections with Probable Clean-Scanning	Number of Inspections Available	Percent of Inspections with Probable Clean-Scanning
VIN/eVIN Mismatch	149,978	5,620,902	2.7%
Electronic & Supported Monitor Profile Mismatch	23,628	713,594 (retests)	3.3%
Switch LD to HD on Retest	918	485,166 (retests)	0.2%
Retest Too Close in Time to Initial	11,747	511,534 (retests)	2.3%
Total Suspected OBD Clean-Scanning			3.3% minimum; 8.5% upper limit

of each of the measures is different, because the dataset was prepared differently for each measure (i.e., using only inspections with an eVIN recorded, or only retests on the same analyzer, or only retests within two weeks of the initial, etc). Also, although we looked at inspectors with especially high or low mean inspection failure rates, that measure is not included in Table 5-31, because this table represents individual inspection results.

It is not straightforward to obtain a total overall clean-scanning percentage from Table 5-31, since each of the percentages were calculated individually, and a given OBD inspection might be represented in one, two, or more lines of the table (i.e., one inspection might have a VIN/eVIN mismatch as well as a retest too close in time to the initial). Thus the total at the bottom of the table provides a range, rather than a single conclusive number, and the lower result of 3.3% is probably more accurate than the upper maximum of 8.5%. This means that around 4% of OBD inspections may be affected by clean-scanning. In the future, additional analysis using some of the new methodologies described in Section 4 of this report could help further quantify the estimate of fraud (and help identify stations and inspectors where this fraud is occurring). Additionally, it was seen in the previous sub-sections that some of the forms of clean-scanning are more common for the oldest OBD vehicles (model years 1996-1998), and these are the vehicles most likely to be contributing excess emissions and to be in need of a repair.

5.4 Recommendations

The analysis in this section has identified several steps in the I/M inspection process that could reduce the incidence of non-compliant or fraudulent OBD inspections.

5.4.1 Preventing Non-Compliant OBD Inspections

For the most part, non-compliant OBD inspections do not appear to impact a large percentage of I/M tests in the Texas program. Below are listed some suggested software changes that could help reduce non-compliance:

- Require that repair information be entered. This would include:
  - Eliminating the “MISC” choice for repair types (possibly requiring that other repair types be added), or require an explanation for the “MISC” repair type,
  - Disallowing costs of $0 from being entered, or require an explanation for a $0 repair cost entry

- Add a routine to the inspection database that performs a real-time calculation of the VIN check digit, and requires that the VIN be re-entered if an error in the check digit is found (for 1981 and newer vehicles only).

- Implement a software change that would require regular use of the barcode scanner (enforced by an analyzer lockout) to minimize the number of VINs entered by keyboard

5.4.2 Preventing Fraudulent OBD Inspections

OBD clean-scanning appears to be occurring at a low (but non-zero) rate; some software changes could be helpful in making OBD fraud more difficult:

- If an eVIN is downloaded from a CAN-protocol vehicle, and if it does not match the VIN for the inspection record, this should raise serious red flags. The analyzer being used to perform the inspection should provide an alert to the vehicle inspector that the eVIN and VIN do not agree and that notice of the disagreement is being sent to an I/M program authority for investigation. The VIN/eVIN mismatch trigger probably identifies a lot of the clean-scanning (for CAN-equipped vehicles); In addition, if there was an additional "repeat eVIN" trigger, that would be helpful as well, because it was seen that many stations/inspectors use the same vehicle over and over again for clean-scanning.

- If vehicle information changes from the initial inspection to the retest inspection (supported monitor profile, PCM ID and PID count, light duty/heavy duty designation), the response should be similar to the above actions for VIN mismatches: a real-time alert should let the inspector know that an initial inspection to retest inspection mismatch has been identified and will be investigated. Then a tool such as the triggers should be used to track the fraction of mismatches out of total inspections for each inspector.

- Analyzer software functionality should prevent conversion of GVWR from below 8501 lbs to 8501 lbs or more on a retest.

- For the retests that follow initial inspections very closely in time, the collection of additional detail about the repairs that were performed, and the total cost of those repairs, could be useful. Even better, if a retest were initiated within a certain short time (such as 15 minutes) after an initial inspection, the analyzer software could require the inspector to enter a comment on how the vehicle was repaired so quickly.

- Include evaluation of communication protocol analysis (in addition to monitor "supported" vs. "unsupported" profile analysis) in order to identify (and prevent) clean-scanning (Section 4.2)

- As described in Section 4.4, consider implementing methods of monitoring / recording live data parameters in order to identify (and prevent) use of OBD emulators and OBD simulators

6.0 Conclusions and Recommendations

The results of this report provide a number of options for the TCEQ to consider as the non-OBD fleet diminishes in size and more attention and resources can be devoted to the OBD inspection component of the I/M program. A considerable list of general OBD program enhancements was considered and discussed in Section 3, and this review included seeking the input from other administrators of state I/M programs. Although the numerous ideas were evaluated with regard to both how the test is administered as well as emissions benefits, ERG's recommendation at this time with regard to testing of CAN vehicles, keyless ignition vehicles, hybrid vehicles, alternative fuel vehicles, MY exemptions, gas cap testing and configurable program tables are in keeping with current best practices. A number of program options are discussed that could be considered in the OBD program by the TCEQ in the future such as OBD analyzer audit enhancements, use of additional monitor "supported" vs. "unsupported" criteria in fraud prevention, testing of light-duty diesel vehicles, and testing medium- and heavy-duty vehicles. Specific OBD program enhancements were presented in Section 4, and it is ERG's view that each of these should be given consideration for implementation as budget constraints allow. During this process it is worth monitoring developments in other state I/M programs to gain insight from their successes and difficulties as they implemented similar strategies.

Section 5 outlines a large number of analyses that could be pursued to improve the fraud detection and prevention capabilities of OBD testing. The results of the triggers analyses indicate that this system can be used to identify suspicious testing activity at both the station and inspector level, even providing the VIN and owner of a vehicle that appears to be used for clean-scanning fraud. Examples of this were illustrated using the eVIN and Readiness triggers. Section 5.4 highlighted the results of the analyses using the TIMS program data. This work with the TIMS data includes recommended program changes for addressing non-compliant testing, as well as preventing fraudulent testing.

7.0 References

1. “Evaluation of the Texas Inspection and Maintenance Program in the Dallas-Fort Worth and Houston-Galveston-Brazoria Nonattainment Areas”, Final Report, Eastern Research Group, November 30, 2009.

2. “Evaluation of the Texas Inspection and Maintenance Program in the Dallas/Fort Worth and Houston-Galveston-Brazoria Nonattainment Areas”, Final Report, Eastern Research Group, November 30, 2006.

3. “Estimates of Emission Reductions from Performing OBDII Tests on 1997 and Newer Diesel Vehicles up to 14,000 lbs GVW”, Final Report, Eastern Research Group, October 7, 2008.