UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR AND RADIATION

MEMORANDUM

DATE: March 07, 2013

SUBJECT: "Best Practices for Addressing OBD Readiness in IM Testing of Diesel Vehicles Under 14,000 Pounds Gross Vehicle Weight Rating"

FROM: Leila Holmes Cook, Director
State Measures and Transportation Planning Center
Transportation and Climate Division

TO: Vehicle Inspection and Maintenance (IM) Program Managers and Technical Workgroup Participants

This memo transmits the above-named "Best Practices for Addressing On-Board Diagnostic (OBD) Readiness in IM Testing of Diesel Vehicles Under 14,001 Pounds (lbs.) Gross Vehicle Weight Rating (GVWR)" which was prepared primarily by Eastern Research Group (ERG) under contract to U.S. EPA with input from a group of outside experts in the field of onboard diagnostics (OBD) testing issues as they apply to light- to medium-duty diesel vehicles. In providing this technical forum EPA was responding to requests for program implementation advice from state IM programs interested in pursuing OBD testing of light- to medium-duty diesel vehicles. While testing these vehicles is not mandatory, EPA was also responding to concerns expressed by diesel vehicle manufacturers and their representatives that testing such vehicles using EPA's guidance for OBD testing of gasoline-fueled vehicles could lead to high rejection rates of vehicles for having too many unset readiness monitors. The attached document reflects the thinking of the workgroup participants regarding the best way to minimize motorist inconvenience due to readiness-related issues when testing these vehicles. This document is provided as a courtesy by EPA to interested states to help those who choose to test these vehicles, but should not be construed as an endorsement of such testing, nor as official EPA guidance on the matter.

Best Practices for Addressing On-Board Diagnostic (OBD) Readiness in IM Testing of Diesel Vehicles Under 14,001 Pounds (lbs.) Gross Vehicle Weight Rating (GVWR)

Background

Although not required by EPA regulation, a number of state inspection and maintenance (IM) programs are currently performing on-board diagnostic (OBD) tests on model year 1997 (MY 1997) and newer OBD certified light-duty (LD) and medium-duty (MD) diesel vehicles. Some reasons cited by states for testing these vehicles include the following:

- Overall equity, because MY 1996 and newer gasoline vehicles equipped with the same OBD technology are required to be tested in areas which operate IM programs
- From a technical standpoint, it seems logical to include these vehicles in the IM program if indeed they are equipped with OBD technology.
- Although exhaust from newer diesel vehicles contains much less smoke than in the past, it can still be visible at times, and this in turn can lead to the public raising the question as to why these vehicles are not required to be tested.
- Finally, if OBD testing of these vehicles proves viable and the emission benefits can be quantified, there is a possibility that those states with challenging air quality goals will look to include these benefits in future air quality planning projections. However, the issue of credit in state implementation plans is not part of this workgroup's charge.

Issue Statement: OBD readiness status has been identified as an important component when IM testing a gasoline-fueled vehicle because it helps ensure that the vehicle's emission system is performing properly and also helps in detecting attempts to fraudulently pass an IM test. Similarly, OBD readiness must be addressed when conducting OBD tests on LD/MD diesel vehicles. However, diesel emission control technology and monitoring strategies differ significantly compared to gasoline vehicles and, therefore, it is not a given that readiness can be treated the same way for these vehicles as for their gasoline-fueled counterparts.

Specifically, some diesel OBD monitors, such as the particulate matter (PM) filter monitor, can take much more time to set readiness than comparable gasoline monitors. A gasoline OBD system may typically run all monitors within two weeks, while a diesel OBD system can take eight weeks or more to run all monitors. This is because certain diesel monitors are often linked to PM trap regeneration, and multiple regeneration events may be required to establish readiness. These monitors may include major emission controls such as the PM filter, the NMHC (non-methane hydrocarbon) catalyst, the oxides of nitrogen (NOx) and selective catalytic reduction (SCR) aftertreatment devices and, in some cases, exhaust sensors. Therefore, using the same readiness criteria (i.e., how many monitors can be "not ready" without the vehicle being failed or rejected) as provided for gasoline vehicles may result in an intolerable number of readiness failures for LD and MD diesel vehicles. The diesel readiness criteria recommended by the workgroup to address this issue is described in the sections below.

Formation of Workgroup: EPA identified recognized experts in the field of OBD diesel technology. EPA then tasked Eastern Research Group, Inc. (ERG)[1] to convene a workgroup

[1] Eastern Research Group, Inc. (ERG) EPA contract EP-C-11-046, Work Assignments 0-10 and 1-10.

comprised of those recognized experts. The purpose of the workgroup was to develop a best practices document (BPD) to address OBD readiness issues for those programs wishing to perform OBD tests on diesel vehicles less than or equal to 14,000 lbs. GVWR. The members of the workgroup are listed in Appendix A.

Scope: The scope of this document is limited to MY 1997+ OBD-equipped diesel vehicles less than or equal to 14,000 lbs. GVWR. This GVWR range covers LD diesel (≤8,500 GVWR) and MD diesel (>8,500 and ≤14,000 GVWR).

Technical Information

There are a number of basic requirements covering various vehicle parameters and test procedures that are already being used for gasoline vehicle inspections that should also be followed in diesel OBD testing. This section provides an overview of typical major elements of an OBD inspection and, where relevant, a comparison between typical diesel and gasoline vehicles with respect to the element. This section is not meant to be an exhaustive list of all elements of an OBD inspection.

1. Diagnostic Trouble Codes (DTCs): DTCs are used by the OBD system to identify malfunctioning components or systems. Generic fault codes[2] are used for both gasoline OBD systems and diesel OBD systems. Existing IM equipment can read codes from diesel vehicles in the same manner with which they are read from gasoline vehicles.

2. Permanent Diagnostic Trouble Codes (Permanent-DTCs): Permanent-DTCs are an additional feature that was phased-in on the OBD systems of MY 2010 through 2012[3] gasoline and diesel vehicles. Because this BPD will include recommendations to use Permanent-DTCs when evaluating the readiness status of diesel vehicles so equipped, some background information on Permanent-DTCs is provided below.

The primary difference between a Permanent-DTC and a regular DTC is that Permanent-DTCs are stored in memory and cannot be erased with scan tools (generic, aftermarket, or manufacturer-specific) or by disconnecting the battery, but instead can only be erased by the OBD system itself. When the Malfunction Indicator Light (MIL) is commanded "on" in a vehicle that supports Permanent-DTCs, the trouble code is stored as both a regular DTC and also as a Permanent-DTC. Unlike the regular DTC, the Permanent-DTC is written to non-volatile memory (NVRAM) at the end of the key cycle[4]. Once stored, Permanent-DTCs can only be erased by the OBD system itself in one of two ways. First, if a scan tool "code clear" has not been received, the Permanent-DTC will be erased at the same time the MIL turns off (e.g., if the OBD system detects that a fault is no longer present on three consecutive trips, it will extinguish the MIL and erase the Permanent-DTC). Secondly, if a scan tool "code clear" has taken place

[2] SAE J2012

[3] Note Title 13, California Code of Regulations, Section 1968.2 and 40 CFR Part 86.008-10 and 86.010-2. Beginning with MY 2010, Permanent-DTCs were phased-in. Fifty percent of the fleet was required to be Permanent-DTC compliant in MY 2010; 75% in MY 2011, and 100% in MY 2012. This requirement applied to both the gasoline and diesel fleets. A scan tool complaint with SAE J1979 version May 2007 or newer will be capable of automatically determining if a vehicle supports Permanent-DTCs.

[4] NVRAM retains its information when power is turned off. This is in contrast to dynamic random access memory and static random access memory which both retain data only for as long as power is applied.

(e.g., technician clears codes after repairing a fault), the Permanent-DTC will not be erased until the monitor responsible for setting that specific Permanent-DTC has run at least once and confirmed that the fault is no longer present. The system is designed to be able to store at least four Permanent-DTCs at one time. Should a vehicle have more than one DTC currently commanding the MIL on, all of the faults would be stored as Permanent-DTCs and could not be erased until the monitors responsible for each of the Permanent-DTCs has run and confirmed that each of the faults has been corrected. Permanent-DTCs are reported through a different scan tool command (J1979 Mode/Service $0A) than regular DTCs, so inspection equipment/tools can distinguish between the two.

Permanent-DTCs have been implemented to make it more difficult for a vehicle owner or technician to clear the fault memory, which can potentially allow the vehicle to pass inspection without being repaired. While readiness monitors were also originally intended to address this issue, Permanent-DTCs address many of the shortcomings that have led to the existing readiness policy. Permanent-DTCs also provide a much more direct and accurate indication that an attempt may have been made by a vehicle owner or technician to circumvent the inspection. Specifically, readiness monitors can be unset for multiple reasons, including those unrelated to a recent emission-related fault, while the presence of a Permanent-DTC provides a definitive indication that the car being inspected previously had the MIL on for that very fault and has not yet re-run that very same diagnostic to determine if the fault is still present. Like unset readiness, the presence of a Permanent-DTC does not definitively tell you if the vehicle still has a fault or not so it is appropriate to have such cars fail the readiness check until either the Permanent-DTC is erased (because the fault is gone) or the MIL is back on because the fault was re-detected.

Given that Permanent-DTCs are phased in over the 2010 through 2012 model years and that diesel vehicles generally make up a small portion of a vehicle manufacturer's fleet, Table 1 was created to generally identify when most diesel vehicles had the feature implemented. However, per J1979, scan tools and/or inspection equipment can be designed to automatically determine if a vehicle supports Permanent-DTCs. Use of a scan tool is the more accurate (and preferred) method for making this determination in an inspection program.

Table 1: Manufacturer Permanent-DTC Compliance[5]

Manufacturer	MY with full Permanent-DTC Compliance
BMW	2012
Cummins	2010
Ford	2012
GM	2012
Mercedes	2012
VW	2012

[5] One hundred percent manufacturer compliance with Permanent-DTC reporting for all vehicles and engines began with the 2012MY the compliance deadline for the phase-in period. However, certified engines are often installed in vehicles that are a model year newer. Therefore, some 2012 medium-duty vehicles may be equipped with 2011 model year engines that may not support Permanent-DTCs. All 2013 and later model year medium-duty vehicles should be equipped with engines that support Permanent-DTCs.

3. MY coverage: Newer diesel vehicles have been equipped with increasing numbers of emission controls because tailpipe emission standards have become more stringent. Accordingly, more diagnostics have been incorporated into OBD systems to monitor the various controls. While there are various milestones that have occurred over time with respect to what typical emission controls were implemented in what timeframe, the testing options described in this best practices document are designed to apply to all OBD equipped diesel vehicles.

4. Communication protocols: Light duty and medium duty diesel vehicles use the same communication protocols that gasoline vehicles use. Therefore, the existing hardware and software currently in use for gasoline OBD IM testing should also be able to communicate with LD and MD diesel vehicles. As a point of reference, all MY 2008 and newer diesel vehicles with GVWRs ≤14,000 lbs. are equipped with the ISO 15765 Controller Area Network (CAN) communication protocol.

5. OBD readiness monitors: There are 11 readiness monitor bits in a diesel OBD system, which is the same number as in a gasoline OBD system. However, as can be seen in Table 2, only nine of the eleven bits are actually assigned to monitors at this point. Also, the monitor descriptions are different[6] from comparable gasoline-fueled vehicles for MY 2010 and newer diesel vehicles, reflecting the fact that the different fuel systems use different emission controls. For example, a state's current vehicle inspection report (VIR) that identifies the 4th monitor as the "Catalyst" in a gasoline vehicle should report the monitor as the "NMHC Catalyst" in a 2010 or newer diesel vehicle (the readiness status of both are reported under SAE J1979 Parameter Identification (PID) $01, Byte D, bit 0)[7]. Per SAE J1979, inspection equipment can be designed or updated to use information in the readiness data itself (PID $01, Byte B, bit 3) to automatically determine whether the gasoline and pre-MY 2010 diesel monitor descriptions or the MY 2010+ diesel monitor descriptions apply to the vehicle.

Table 2: Gasoline and Diesel OBD Readiness Monitors

Monitor Number	Readiness Monitor Assignments for all Gasoline and for Diesel through MY 2009	New Readiness Monitor Assignments for Diesel from MY 2010+
1	Misfire	Misfire
2	Fuel System	Fuel System
3	Comprehensive Components	Comprehensive Components
4	Catalyst	NMHC Catalyst
5	Heated Catalyst	NOx/SCR Aftertreatment
6	Evaporative System	(Reserved for future)
7	Secondary Air	Boost Pressure
8	A/C	(Reserved for future)
9	O2 Sensor	Exhaust Gas Sensor
10	Heated O2 Sensor	PM Filter
11	EGR/VVT	EGR/VVT

[6] SAE J1979 PID$01,Data Bytes B(bit #3), C, and D

[7] For a comprehensive list of OBD PIDs, refer to SAE J1979.

Also, in a gasoline OBD system, the first three monitors in Table 2 above are considered "continuous" and therefore are always reported as complete and/ or ready. As a result, many states do not include these three monitors as part of the IM readiness evaluation. However, for LD and MD diesels vehicles, only the last of the first three monitors – "comprehensive components" – is always reported as complete and/or ready. Accordingly, this BPD recommends that IM programs consider all assigned readiness monitors when evaluating the readiness status of OBD-equipped, LD and MD diesel vehicles.

6. Diagnostic Link Connector (DLC), Communications, and DTC Issues: The existing recommendations for gasoline OBD systems with regard to DLC issues such as "missing," "tampered," or "malfunctioning DLCs" should be followed for diesel OBD test programs as well. Likewise, "failure to communicate", pending DTCs, DTCs with no MIL illumination, and/or a MIL commanded on with no DTCs should all be handled in the same way as in the state's current gasoline IM program.

7. Fraud Detection: Programs should use the same techniques for detecting "fraud" and "tampering" as in the state's current gasoline IM program.

8. Individual Monitor Exemptions or Requirements: Although not required, many states have found it beneficial to design their inspection software to provide "readiness exceptions" for certain problematic vehicles. Options have included allowing a greater total number of "not ready" monitors (i.e., 2 instead of 1) and the ability to "ignore" a specific monitor[8] when making the IM readiness determination for a specific vehicle. These exceptions can prevent motorists from having their vehicles rejected for readiness when in reality there is nothing they can reasonably do to bring the vehicle into compliance with the base readiness criteria.

   Conversely, some IM programs for gasoline-fueled vehicles have required the catalyst monitor to be set to complete for the initial test (and for the re-inspection in cases where the vehicle was initially failed for a catalyst-based DTC). This requirement helps to further protect emission benefits by ensuring that the most important emission control has been monitored and passed at the time of the inspection. Other states have accepted proof of repair in lieu of meeting certain readiness criteria (for example, proof of a catalyst repair in lieu of the catalyst monitor being set to ready for the re-inspection). These variations can further help to balance motorist inconvenience considerations with the need to ensure that critical emission controls are functioning properly and that components in need of repair have indeed been repaired.

   It is recommended that programs that have these types of flexibilities for gasoline vehicles also use them as needed for diesel vehicles, and states should consider including such capabilities in any future software revisions or upgrades.

[8] For example, the 1997 Toyota Tercel and Paseo were unable to set the Evaporative monitor. These vehicles were subsequently identified in EPA's OBD Guidance, Appendix D. These vehicles, and others, are also included in EPA's document entitled "OBD Readiness Testability Issues" (EPA-420-B-12-044, June 2012) which updates and replaces the original Appendix D.

9. Confirmation of Fuel Type: States should evaluate the effectiveness of their current procedures for identifying vehicle "fuel type" so that gasoline and diesel vehicles are tested based upon the appropriate testing criteria. Methods for confirming vehicle fuel type include enhanced Vehicle Identification Number (VIN) decoding and/or completing additional OBD requests (PID $51, or PID $01/Byte B/bit3) while scanning the vehicle.

LD and MD Diesel IM Readiness Evaluation Recommendation

Figure 1 provides a test logic flowchart for performing an IM OBD test on diesel vehicles and is designed to cover OBD equipped diesel vehicles ≤14,000 lbs. GVWR. The process logic follows the path described below. The recommendations listed in 3a and 3b are those that programs should be able to implement immediately as they do not require software or hardware upgrades to read Permanent-DTCs from newer vehicles.

1. Follow all other aspects of inspection protocol prior to readiness evaluation (e.g. visual emission-control inspections and inspection of the MIL status)[9].

2. If the vehicle supports Permanent-DTCs and the state's IM program equipment can access the Permanent-DTCs, then the Permanent-DTCs should be used in conjunction with readiness monitor status and other criteria such as distance traveled and/or number of warm-ups since the DTCs were cleared to make a readiness determination[10].

3. If the vehicle does not support Permanent-DTCs or the state's IM program equipment cannot access the Permanent-DTCs, then the procedures below may be implemented[11]. However, in cases where the vehicle supports Permanent-DTCs but the state's equipment cannot read them, it should be noted that this method is less robust and should only be used as an interim solution until the IM equipment can be updated because these options will likely lead to relatively greater motorist inconvenience in some cases and reduced emission benefits in other cases.

    a. If the vehicle has ≤1 monitor not ready, then the vehicle passes the readiness determination[12]. If the vehicle does not meet this criterion, then move on to the readiness criteria in Step (b) below to provide relief as appropriate to diesel vehicles mapped to the new diesel readiness indicators.

    b. Use the less stringent readiness monitor criteria of 2 not ready monitors in conjunction with a more rigorous (as compared to #2 above) distance traveled

[9] As described in the Background section of this document, diesel vehicles may require additional time compared to gasoline vehicles to set readiness monitors after a repair. To address this difference, this document recommends that vehicle operators be instructed to drive vehicles for two or three weeks after codes are cleared to provide for readiness monitor setting before an inspection as opposed to the one week that is often used in gasoline applications.

[10] The terms "fail readiness determination" or "fail readiness check" are used here and throughout this document to refer to a vehicle that does not meet a given set of readiness criteria. The final IM test outcome for such vehicles can vary on a state-by-state basis depending on their regulatory requirements and each state should proceed accordingly to fail for readiness, reject from testing, etc.

[11] This is the path described below in #2 "No use of Permanent-DTCs and ≤1 unset monitors".

[12] This is the current readiness criteria used for gasoline vehicles.

and/or number of warm-ups since the DTCs were cleared if supported[13]. In order to pass readiness in this step, both of the unset readiness monitors must be within the categories of PM Filter, NOx/SCR aftertreatment or NMHC Catalyst for vehicles mapped to the new diesel readiness indicators (i.e., MY 2010+ diesel vehicles), and within the categories of Catalyst, Heated Catalyst, or O2 Heater for those that are not.

The requirement that a minimum distance be traveled or a minimum number of warm-ups occur since the last time a vehicle's OBD codes were cleared (both of which can be read directly by technicians with a scan tool)[14] can best be communicated to individual drivers that fail to meet these criteria in terms of their needing to operate the vehicle normally for a prescribed minimum amount of time before returning for re-inspection. In the options outlined below, the workgroup has recommended two or three weeks as a good initial starting point for the paths outlined in Figure 1, however, each state has the discretion to modify these times following consultation with EPA.

These options and associated paths are outlined in Figure 1 and described in more detail below.

1. Use of Permanent-DTCs (right-hand side of Figure 1)

It should be noted that implementing the recommendations of this document, including using Permanent-DTCs, will likely require revision to current IM inspection software and associated databases. For example, the IM scan tool will need to use a different command to read Permanent-DTCs; the electronic inspection record will need to be revised to include Permanent-DTC related data; the IM database must be adapted to store the additional data; and some states may even change the program's vehicle inspection report (VIR) to identify the presence of a Permanent-DTC as the cause of the IM failure. Full implementation of the recommendations will likely vary from state to state as individual states will need to take into account their current contract structure and timing, equipment capability, and even associated regulatory changes necessary to identify the criteria in regulation. However, as noted above, interim implementations that do not use Permanent-DTCs will be less effective and likely have increased motorist inconvenience for some vehicles.

The Permanent-DTC option is illustrated on the right side of Figure 1 with the key decision blocks colored in blue. If a vehicle is presented for testing and the MIL is not commanded on, the scan tool will query the OBD system to determine if the vehicle supports Permanent-DTC technology. If it does, and there are Permanent-DTCs stored, then the vehicle should be checked to see if it has any known testability issues. If it does not, then the vehicle will fail the readiness check (unless the vehicle has a known testability issue that would make the failure determination inappropriate at this point).

[13] If the scan tool or vehicle software does not support checking miles traveled and number of warm-up cycles since code clearing, then the vehicle may also pass the readiness determination at the state's discretion.

[14] This information is stored in PIDs $30 and $31. Temporary disconnection of the battery may cause these counters to reset to zero. Vehicles with multiple controllers may report different values for the number of warm-up cycles and distance traveled. In such cases, the minimum values reported should be used to determine if the recommended target values for these parameters have been met. These recommended targets are discussed in more detail below.

If the vehicle supports Permanent-DTCs and there are no Permanent-DTCs stored, there is higher confidence that the vehicle likely does not have an unrepaired fault. There is no recommended limitation on the types of 2 or fewer incomplete readiness monitors[15] in the second blue decision block to determine whether to check the vehicle for known testability issues or move to the next blue decision block checking for 1 or 0 incomplete readiness monitors.

While the absence of a stored Permanent-DTC does greatly increase the confidence that the vehicle does not have an unrepaired fault present, there are still a few scenarios where faults could be present without a Permanent-DTC stored (e.g., a recent reflash or reprogramming of the vehicle, or multiple sequentially monitored components that have failed but have been disabled due to the first fault[16]). As such, readiness monitors are still used as a backstop to help address this concern in the third blue decision block, where, if the vehicle has one or fewer unset readiness monitors, then it should pass the readiness determination.

If there are two unset readiness monitors, then in the fourth blue decision block it is determined if the distance since the last code clear is more than 500 miles[17] and if the number of warm-ups since code clear (WU-SCC) is greater than thirty[18]. If both of these criteria are met, then the vehicle should pass the readiness determination. If not, the process should proceed to the fifth blue decision block, where it is determined if the vehicle has known testability issues

This will require programs to track and tabulate those specific vehicles (i.e. Make/Model/MY, VIN strings) that have demonstrated repeated known readiness problems. The workgroup recommends such a list be compiled and maintained by a group of states performing OBD diesel testing in consultation with EPA. The list could be distributed through posting on the OBD Clearinghouse web site and at the IM Solutions Conference or other public forums.

2. <u>No use of Permanent-DTCs and ≤1 unset monitors (left-hand side of Figure 1)</u>

If a diesel vehicle does not support Permanent-DTC technology (or if a program's IM scan tools cannot request Mode $0A data), then a readiness criteria of ≤1 unset monitor is recommended. This is the first green decision block to the left of Figure 1. Although many MY 2009 and newer diesel vehicles may have difficulty meeting the current gasoline readiness criteria of one or fewer unset readiness monitors if codes were recently cleared, some may be able to pass this criterion and if they can it is recommended that they pass the readiness check.

[15] The less stringent criterion of any 2 was chosen because the diesel Permanent-DTC path in the test logic flowchart is a more stringent test than the other option described below. The other option requires more stringent distance and warm-up criteria.

[16] With most OBD systems, relevant monitors may become disabled upon detection of a fault with one or more related components. If the vehicle owner ignored the detected fault for a substantial period of time, other components could have subsequently malfunctioned but will not be monitored until the first malfunction has been repaired. Therefore, requiring some or all readiness monitors to be complete will increase the likelihood that the vehicle is not in a condition to trigger a "chain" of successive faults after the first one is finally repaired.

[17] This figure is based on an estimated annual driving distance of 12,000, or 1,000 miles per month. Therefore, it is anticipated a vehicle will be driven on average about 500 miles in two weeks and 750 miles in three weeks. The vehicle owner should be instructed that normal operation on both city and highway routes is most effective in setting readiness monitors.

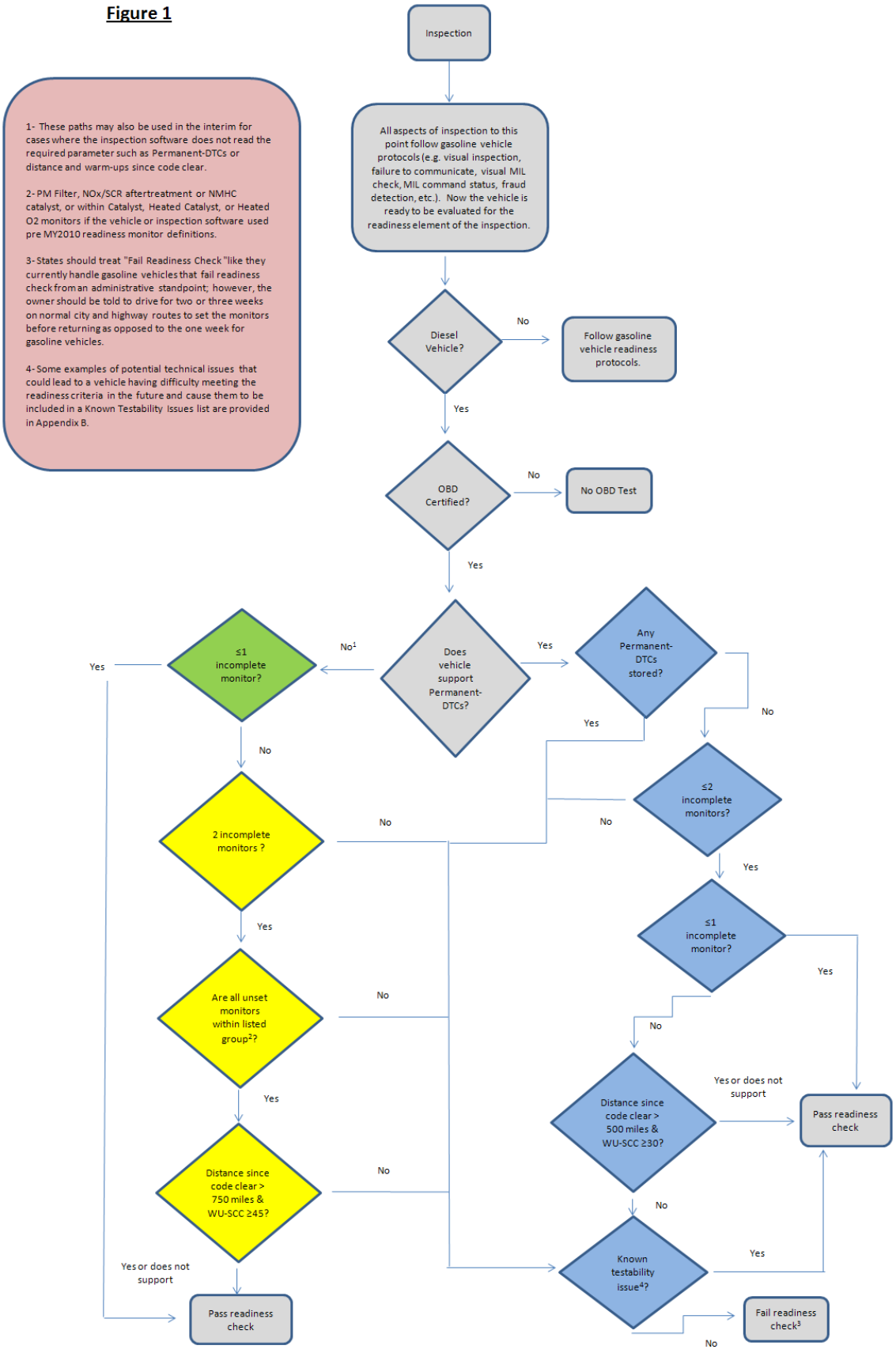
[18] The value of 30 warm-up cycles is based on an assumed average of 2 warm-up cycles per day or 14 per week. The workgroup recommends using 30 warm-up cycles to represent an average for a two week period and 45 warm-up cycles for a three week period.

If the number of unset monitors is greater than one, the vehicle moves to the first yellow decision block where if there are three or more unset monitors of any type the vehicle should fail the readiness check. However, if there are two unset monitors and both are for monitored controls that are known to be difficult to set (i.e., the PM Filter, NOx/SCR after-treatment, or NMHC catalyst), then in the second yellow decision block it is determined if more than 750 miles have been driven and at least 45 warm-up cycles have occurred since the last code clear[19]. If these conditions are met then the vehicle should pass the readiness determination. If the scan tool or vehicle software does not support checking miles traveled and number of warm-up cycles since code clearing, then the vehicle may also pass the readiness determination at the state's discretion. Otherwise, the vehicle should fail the readiness check.

The criteria in this scenario are more stringent than in the case where Permanent-DTCs are supported primarily because of the higher confidence the absence of Permanent-DTCs provides in assessing whether the vehicle has an emissions related problem. Furthermore, older vehicles that do not support Permanent-DTCs typically have fewer readiness monitors. Therefore, it is appropriate to further limit which monitors can be incomplete and to require additional vehicle operation time since the last code clear to help ensure that fault codes have not been erased without the owner having performed the necessary repairs.

[19] The value of 2 unset monitors among this group was chosen based on an analysis of existing data from Massachusetts that demonstrated using 2 unset monitors (regardless of which ones they were) instead of 1 resulted in LDD vehicle Make/Model categories with initial not ready rates in the range of 0-9%. Using the ≤1 criteria resulted in initial not ready rates in the range of 0-13%. The overall MD diesel vehicle initial not ready rate fell from 7% to 3% with the ≤2 criteria. This analysis is based on 5,817 LD diesel and 3,232 MD diesel vehicle initial OBD tests performed in Massachusetts on MY 2010-2012 collected in 2010-2012. It is recommended that similar analyses be performed as additional OBD diesel data becomes available to confirm the validity of these criteria or provide information that will support adjusting the criteria accordingly.

Figure 1


1- These paths may also be used in the interim for cases where the inspection software does not read the required parameter such as Permanent-DTCs or distance and warm-ups since code clear.
2- PM Filter, NOx/SCR aftertreatment or NMHC catalyst, or within Catalyst, Heated Catalyst, or Heated O2 monitors if the vehicle or inspection software used pre MY2010 readiness monitor definitions.
3- States should treat "Fail Readiness Check "like they currently handle gasoline vehicles that fail readiness check from an administrative standpoint; however, the owner should be told to drive for two or three weeks on normal city and highway routes to set the monitors before returning as opposed to the one week for gasoline vehicles.
4- Some examples of potential technical issues that could lead to a vehicle having difficulty meeting the readiness criteria in the future and cause them to be included in a Known Testability Issues list are provided in Appendix B.
Inspection
All aspects of inspection to this point follow gasoline vehicle protocols (e.g. visual inspection, failure to communicate, visual MIL check, MIL command status, fraud detection, etc.). Now the vehicle is ready to be evaluated for the readiness element of the inspection.
Diesel Vehicle?
No
Follow gasoline vehicle readiness protocols.
Yes
OBD Certified?
No
No OBD Test
Yes
Does vehicle support Permanent-DTCs?
No1
Yes
Any Permanent-DTCs stored?
Yes
No
≤1 incomplete monitor?
Yes
No
2 incomplete monitors ?
No
Yes
Are all unset monitors within listed group2?
No
Yes
Distance since code clear > 750 miles & WU-SCC ≥45?
No
Yes or does not support
Pass readiness check
≤2 incomplete monitors?
No
Yes
≤1 incomplete monitor?
Yes
No
Distance since code clear > 500 miles & WU-SCC ≥30?
Yes or does not support
Pass readiness check
No
Known testability issue4?
Yes
No
Fail readiness check3

Appendix A: Workgroup Members

The workgroup members are listed below.

State:
California Air Resources Board- Mike McCarthy, Allen Lyons
Massachusetts Department of the Environment- Craig Woleader, Julie Ross, Paul Davis
New Jersey Department of Environmental Protection- Bill Etherington, Tom Dvorak
New York Department of Environmental Conservation- Jim Clyne, Greg English
Utah Department of Environmental Protection- Joe Thomas, Chris Woodhave

Industry:
Cummins- Mark Stepper, Robert Weiss, Greg Pataky
Ford- Ken McAlinden
General Motors- Dave Ferris, Chris Brown
Volkswagen- Bob Gruszczynski, Volker Lantzsch
BMW- Carl Heinz Bayer, Edwin Bachhelm
Mercedes- Ashim Manchanda

Associations:
Auto Alliance- Steve Douglas
Engine Manufacturers Association- Lisa Stegink

Environmental Protection Agency:
Office of Transportation and Air Quality- Patty Klavon, Dave Sosnowski

Contractor:
Eastern Research Group- Mike Sabisch, Diane Preusse, Jim Lindner

Appendix B: Known Testability Issues

The EPA guidance document "Performing Onboard Diagnostic System Checks as Part of a Vehicle IM Program" released in June 2001 contained an appendix (Appendix D) that identified those gasoline vehicles by Make/Model/MY that were known to have difficulty setting readiness or may never set certain readiness monitors. The purpose of Appendix D was to alert IM programs that these vehicles should be handled differently with regard to the readiness criteria when presented for an OBD test. Flexibility was given to states to perform an idle or two-speed idle test on these vehicles or perform an OBD test with less than the required number of set readiness monitors. Since 2001, EPA has updated Appendix D to include additional vehicles that have been identified with readiness issues. In January 2008 the "IM OBD Vehicle Readiness Exception List" was released, and then in June of 2012 the "OBD Readiness Testability Issues" document was published.

Although at this time there is not such a list for diesel vehicles ≤ 14,000 lbs. GVWR, some vehicles may be identified with OBD readiness testability issues after the procedure described in this document and outlined in Figure 1 have been implemented. There is one "Known Testability Issues?" decision block in Figure 1 as a part of the readiness determination protocol (one path of which includes the use of Permanent-DTCs). Two example issues are listed below; however, these are only provided for informational purposes so that states can be made aware of the type of issues that could arise that are unique to diesel vehicles. As stated earlier in the body of this document, the workgroup recommends that a Known Testability Issues document be maintained by the states and shared through the OBD Clearinghouse and IM Solutions.

- Example 1: If the readiness check failed due to the presence of stored Permanent-DTC(s) (right-hand side of Figure 1 path):

  If Permanent-DTCs are being utilized as part of the readiness determination protocol, the process will fail any vehicle that has one or more permanent DTCs present. This is true even if the vehicle has met the readiness criteria. Permanent-DTCs that have dependencies on PM trap regeneration or that have environmental dependencies (such as ambient temperature) may take a long time to clear after a repair has been made and DTCs cleared. Some examples may include PM filter diagnostics, NHMC catalyst diagnostics, PM and NOx sensor diagnostics, NOx catalyst diagnostics, DEF heater diagnostics, and HC doser diagnostics. If this condition occurs, it may be challenging for the driver to get such Permanent-DTCs to clear, possibly taking significantly longer than three weeks of driving in order for the vehicle to accrue sufficient mileage or see the proper environmental conditions (e.g, the proper seasonal conditions) for the monitors to run.

  Vehicles with these types of issues or other types of issues associated with failing readiness due to Permanent-DTCs could be included in a Known Testability Issue document.

- Example 2: If the readiness check failed due to the number of incomplete monitors, having two incomplete monitors of the incorrect type, or insufficient distance or number of warm-ups since code clear (left hand side of Figure 1 path):

  Some vehicles may have more than two readiness monitors that are difficult to set because of dependencies on PM trap regeneration or on operational conditions (such as ambient temperature). For example, certain vehicles may have difficulty setting all three monitors listed in Footnote 2 of Figure 1, or perhaps have difficulty setting monitors not listed in Footnote 2.

  Vehicles with these types of issues or other types of issues associated with failing readiness due to the number of incomplete monitors, having two incomplete monitors of the incorrect type, or insufficient distance or number of warm-ups since code clear could be included in a Known Testability Issue document.