Passenger Car/Light Duty Truck OBD I/M Test Flowchart Attachment
Callout Definitions for Flowchart Version 8.3

The attached document is a guideline in the form of a flowchart to explain the logical steps that could be used by a Test Analyzer System (TAS) when performing the OBD portion of an Inspection and Maintenance test.

This flowchart does not represent the only way that such a test can be performed—it is simply a descriptive example of how it can be done. As such, individual steps, suggested wording, etc. can be altered, modified, re-ordered, etc. to meet an individual state's needs. However, the sequences portrayed by this flowchart are based on actual in-field experiences learned by industry individuals and expert groups. Thus, the steps included here have been specifically designed to minimize the chance for mistakes during the inspection process or to address known vehicle problems.

Wherever possible, the reasoning for such a sequence has been noted either directly on the chart or on the footnote addendum at the end of the flowchart so that if the sequence is modified, appropriate steps may be taken by the state to avoid a problem.

And, as always, this document and EPA's guidance as to how the inspection should be performed are updated periodically as more issues are uncovered or better technical solutions are discovered. Always check with appropriate EPA personnel if you have questions regarding policy or technical decisions in your program.

Definition of callouts for flowchart:

1. In theory, there should not be any problems plugging the connector into a vehicle that has the engine running. The pins in the connector are designed to ensure proper ground occurs before getting power to the pins. However, some had concerns about plugging into a “hot” connector and the chart was designed accordingly. If the sequence is changed to plug in after the inspector does both the KOEO bulb check and KOER visual MIL on check, you would eliminate the known problem 1996 Mercedes vehicles that will constantly illuminate the MIL whenever the connector is plugged in. Further, some states (like Oregon) have found that plugging into the car and performing the test when the vehicle owner drives the car in and before the car has been shut-off helps address even some (but not all) of the known “problem” cars that are usually addressed in other areas such as readiness monitors that reset at key-off on 1996 Subaru’s, etc. This option may be viable in some cases (e.g., centralized test lanes with minimum waiting time and “drive-up” service) but may not be viable in other cases. This option would also require that the bulb check sequence be performed at the end of the test, after all of the OBD II information has been collected and before the vehicle is powered down.

2. MIL bulbs should rarely ever "burn out". Most vehicles identified as failing the bulb check are likely inspector error (didn't see the MIL illuminate, didn't cycle the key off for a long enough period of time). This second loop was designed to make inspectors thoroughly verify a bulb check fail before sending a vehicle owner through the hassle of a false I/M fail. The instructions to remove the key and wait 30 seconds before re-inserting the key may be overkill to ensure that the inspector has performed the check correctly but absolutely minimizes the chance for false fail by inspector error. However, this sequence could obviously be eliminated or modified in many ways based on an individual state’s needs, confidence in proper inspection, etc.

   As an example, the second loop/re-try could only be triggered at the end of the inspection if all other elements of the test passed and the visual MIL was the only thing that failed to increase the confidence that this test was administered correctly when it is the only thing that is going to fail the car. This example of a second retry is included in the flowchart on the pass/fail evaluation page.

3. A loop was constructed to make sure communication was tried several times before deciding it was a communication failure. For some as yet to be determined reasons, some scan tool hardware and some vehicles will fail to synchronize correctly and initialize on the first attempt but will be successful on a second or third try. In any case, the extra time added to a test to repeat this process at least three times is minimal (about 5-10 seconds) and is highly

recommended before concluding the vehicle is a fail for lack of communication.

4. Obviously, once a state inspection program is up and running successfully, the proper step in the case of unsuccessful communication is to fail the vehicle. However, during pilot stages, initial phase-in of the program, beta testing of software, etc., it is highly recommended that a state have a back-up alternative to failing the vehicles to minimize vehicle owner inconvenience due to I/M equipment bugs or failures. Alternatives could be other inspection tests, referee inspections, bypass, etc.

5. This loop was created as a double-check to ensure that the I/M equipment is communicating with all of the OBD computers on the car and not just the transmission controller. This can be extremely helpful during debugging of I/M software for identifying problematic vehicles where communication is not being properly established. Also, from field experience with hand-held scan tools, communication can occasionally be established with a single module but an immediate re-initialization will result in communication with all modules.

6. There is a suggested formula to use for Total_PID_Count that is included in the special note on the right side of the flow chart. It is only one of several ways that this value coud be calculated and it may not be the best method. Other methods could include storing the raw hex responses of the various modules or more complicated formulas that would allow better distinction/'fingerprinting' of vehicles such as in differentiating between two cars that support the same overall number of PIDs but support different individual PIDs. It is absolutely necessary that States that want to collect PID count must specifically define how the PID count is to be calculated so that all I/M equipment vendors within the State will generate the same result.

   An important note on the calculation is that I/M equipment should not attempt to shortcut the process by simply requesting PID $00, then PID $20, then PID $40, etc. and summing the indications of supported PIDs as indicated by the responses from the PID Supported PIDs $00, $20, $40, etc. The equipment must be designed to request PID $00, and then only request PID $20 if PID $00 indicated that PID $20 was indeed supported. PID $40 should be requested only if PID $20 was supported and indicated that PID $40 was supported and so on. If the I/M equipment just requests all of the PIDs in subsequent requests without checking to see if they were supported, some vehicles such as many 2000-2002 Nissans will inappropriately terminate communication and have to be reinitialized.

7. At this time, a lookup table of proper PID count and Module ID relative to vehicle make/model/model year does not exist. Most states will likely need to create this on their own by collecting PID count and Module ID for a few years to gather the data and then going back to create the master list to be used for

subsequent future inspections of those cars. Other states have indicated that they will collect the data and post-process it as part of their QA analysis or enforcement work to catch clean-scanners or investigate suspect stations. Several States have already successfully used this latter technique to identify inspectors performing fraudulent activities and have arrested/fined/suspended inspectors.

It is important to note that adopting a PID Count function, Module ID count function, and any accompanying lookup tables that would be used to post-process the data is up to the State's discretion.

8. This step was inserted to address some problematic Kia/Hyundai vehicles that have a non-OBD II ECU that uses ISO 14230 for non-OBD diagnostics while the OBD II ECUs actually use ISO-9141. The non-OBD vehicle ECU is illegally responding to an initialization message for OBD modules only but then correctly reports that it supports no OBD PIDs.

9. It is not a normal feature of a scan tool or I/M equipment to allow the inspector or I/M equipment itself to specify which protocol to try. The scan tool typically cycles through the protocols automatically and the user has no ability to change the order or start with a specific protocol. However, this is a known problem and scan tools or I/M equipment can be designed to automatically move to the next protocol in the sequence if communication is established on a protocol but no OBD PIDs are supported. Both the I/M equipment vendor and any associated subcontractors (e.g., such as OBD II hardware/software providers) need to work together to ensure the total system is robust to such a vehicle.

10. Using PID $1C OBD Requirements may be an important check to conduct in I/M testing. Currently it can only be used to effectively identify non-California vehicles over 8,500lbs GVWR that do not have OBD II compliant systems (nor are they required to until the 2008 model year for Gasoline and 2007 model year for Diesel). While this flowchart only recommends collecting this data on mode year 2005 and newer vehicles, many earlier model year vehicle support this PID as early as the 1996 model year. Some States may find it useful to also ask for this PID on such cars as the reported information may be helpful when identifying unique vehicles:

    Example 1: Early model year (eg. 1996, 1997) Canadian cars that are not fully compliant to the OBD II standards (nor were they required to be)

    Example 2: Model year 1995 and older non-OBD II vehicle (OBD I)

    Example 3: Vehicles with multiple ECUs which each responding ECU indicates a different OBD Requirement, eg. OBD II+OBDI and OBD I

11. This check for engine speed makes sure the engine is running prior to reading the "commanded MIL" status to avoid falsely failing a car that reads commanded on during bulb check. However, some hybrids like the Toyota Prius, Honda Insight, or many other future models will not have the gasoline engine running during idle so engine speed will properly read <250 rpm and we need to bypass this test. There may be other cases where there is a legitimate reason to bypass this step. It is recommended that the inspector is given a warning message and/or the ability to bypass this requirement and continue the test to accommodate special vehicles or other special circumstances.

12. The language used in this example reflects the new terminology adopted by SAE 1979/ISO 15031-5 and all I/M equipment vendors and scan tool manufacturers are STRONGLY encouraged to use it to help promote a consistent terminology for inspectors and repair technicians. Currently, many different versions are reported including “pass/fail”, “complete/incomplete”, “yes/no”, “ready/not ready”, “done/pending”, etc. and this has led to some confusion.

13. This check for power and ground on the vehicle’s SAE J1962/ISO 15031-3 data link connector (DLC) can aid in determining if the vehicle submitted for an I/M test has a properly operating data link connector. Checks include a test for 12 volt power on pin 16 (device dependant). If there is a failure, then further circuit tests can be performed by a service technician. The optional recommendation here is to fail a vehicle if pin 16 does not have the proper voltage level or if pin 4 or pin 5 are not properly grounded. Note that there are recalls for at least vehicles with a lack of ground at pin 4 or pin 5.

14. Protocol identification can assist in confirming the vehicle under test. Capturing protocol may be a device dependant feature. Once identified, the protocol ID can be stored into a vehicle record, which may be used to “fingerprint” a vehicle or aide in determining a clean-scan attempt.

15. Many states use or require some minimum level of 'successful communication' or 'connectivity' with equipment vendors in their program. Technically, at this point, it is only known that some form of communication was established with the vehicle but it is not known if communication was properly established with all the OBD related modules and/or whether all of the necessary OBD information will be gathered. States may want to consider waiting until some minimum set of data is gathered or some other indications are present that data was likely gathered from all OBD modules before determining that a successful communication event occurred.

16. Readiness (“RDY”) data (mode $01 PID $01) should be combined from all responding ECUs using 'OR' logic to evaluate the number of not ready monitors. In the case of two or more modules responding, 'OR' logic results

in a "1" in cases of where modules report 1 and 0, 0 and 1, or 1 and 1 while it results in a "0" in case of the two or more modules reporting 0. If multiple modules report a monitor as supported and then one or more of them report 'not ready/incomplete' for that monitor, it would result in that monitor being considered 'not ready/incomplete'.

This 'consolidated' readiness would more accurately represent the total vehicle's readiness status than the previously recommended approach. Vehicles primarily affected by this change would be large engines (such as V12 engines) that use two separate engine ECUs (each manages half of the engine) and separately report readiness (“Ready”) data. In the case that both engine ECUs report that the catalyst monitor is incomplete, the old methodology would count that as two not ready/incomplete monitors while this new logic would report that as one not ready/incomplete monitor.

17. Although no technical guidance documents exist as to how this data should best be used in IM programs, some of it was intended to help give IM programs more information/more tools to discriminate between vehicles with some incomplete readiness as to those that have been driven significantly since fault information was last cleared and still have incomplete monitors and those that have been driven very little since fault information was cleared. For example, distance since codes cleared and number of warm-up since code cleared could be used to supplement a decision to accept or reject a car with some monitors incomplete such as allowing one monitor to be incomplete as long as the vehicle has been driven for more than xxx miles since codes cleared and for greater than yy number of warm-up cycles. This could distinguish better between a car that has cleared codes and driven very little in an attempt to get back through re-inspection with some monitors incomplete and not having had time to re-detect an existing fault versus a vehicle that has been driven significantly but certain monitors are still incomplete because they are very difficult to run or are not being satisfied with that particular vehicle owner's driving habits. For distance driven with MIL on or engine runtime since MIL illuminated, this data should not be used in pass/fail decisions but might be useful to state administrators that are modeling emission benefits or investigating consumer response to illuminated MILs, etc.

18. VIN support was not required on vehicles until the 2005 model year. However, many vehicles do support VIN prior to the 2005 model year and some states have found asking and getting VIN information on earlier model year cars can be very useful in identifying fraudulent activities (e.g., the vehicle being tested is different from the vehicle the inspector indicated he was testing). However, because VIN was not mandatory before 2005, there are many in-use vehicles that support VIN but have mistakes in the data (e.g., VIN is populated with junk data, only partial VIN is implemented, VIN is populated with default data, etc.). States choosing to collect VIN on earlier

model year vehicles need to be aware that the data will likely be less robust and contain more errors than it will on 2005 and newer model year vehicles. Also, equipment should be configured to only request and collect VIN data if the vehicle indicates via Mode $09 InfoType $00 that the VIN is actually supported.