SURFACE VEHICLE RECOMMENDED PRACTICE	**SAE**	**J1939-84 DEC2010**
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(R) OBD Communications Compliance Test Cases for Heavy Duty Components and Vehicles

RATIONALE

The development of HD OBD regulations by US EPA and California's Air Resources Board (ARB) require that diagnostic message services are exercised to evaluate diagnostic communication standardization requirements on production vehicles. The December 2008 publication of J1939-84 described a test process for EURO IV and EURO V engine emissions and diagnostics regulations. This version of the document adds a test plan and procedures for ARB and US EPA HD OBD requirements with emphasis on 13 CCR 1971.1 (l)(1) Verification of Standardized Requirements. The prior test procedure has been retained in Section 7. The user should reference the summary provided by J1939-73 Table 1 and Table 2 for OBD compliance support.

FOREWORD

The set of SAE J1939 Recommended Practice documents define a high speed ISO 11898 CAN protocol based communications network that can support real-time closed loop control functions, simple information exchanges, and diagnostic data exchanges between Electronic Control Units (ECUs) physically distributed throughout the vehicle. SAE J1939 network is the next generation successor to the SAE J1708 and SAE J1587 low speed networks. SAE J1708 and SAE J1587 are older, widely used networks intended to provide simple information exchange, including diagnostic data, between ECUs. SAE J1939 is capable of performing all of the functions of SAE J1708 and SAE J1587 networks as well as provides control system support.

The SAE J1939 communications network is developed for use in heavy-duty environments and suitable for use in vertically integrated vehicle industries. The physical layer aspects of SAE J1939 reflect its design goal for use in heavy-duty environments. Vertically integrated vehicles involve the integration of different combinations of loose package components, like as engine and transmissions, which are sourced from many different component suppliers. The SAE J1939 common communication architecture strives to offer an open interconnect system that allows the ECUs associated with different component manufacturers to communicate with each other.

The SAE J1939 communications network is intended for light-duty, medium-duty, and heavy-duty vehicles used on-road or off-road, and for appropriate stationary applications which use vehicle derived components (e.g., generator sets). Vehicles of interest include, but are not limited to, on-highway and off-highway trucks and their trailers, construction equipment, and agricultural equipment and implements.

This set of SAE Recommended Practices has been developed by the SAE Truck and Bus Control and Communications Network Committee of the SAE Truck and Bus Electrical and Electronics Steering Committee. The SAE J1939 communications network is defined using a collection of individual SAE J1939 documents based upon the layers of the Open System Interconnect (OSI) model for computer communications architecture. These SAE J1939 documents are intended as a guide toward standard practice and are subject to change to keep pace with experience and technical advances.

TO PLACE A DOCUMENT ORDER:	Tel:	877-606-7323 (inside USA and Canada)	**SAE values your input. To provide feedback on this Technical Report, please visit** http://www.sae.org/technical/standards/J1939/84_201012
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1. SCOPE

The purpose of this Recommended Practice is to verify that vehicles and/or components are capable of communicating a required set of information, in accordance with the diagnostic test messages specified in SAE J1939-73, to fulfill the off-board diagnostic tool interface requirements contained in the government regulations cited below.

This document describes the tests, test methods, and results for verifying diagnostics communication from an off board diagnostic tool (i.e., scan tool) to a vehicle and/or component. SAE members have generated this document to serve as a guide for testing vehicles for compliance with ARB and other requirements for emissions-related on-board diagnostic (OBD) functions for heavy duty engines used in medium and heavy duty vehicles.

2. REFERENCES

At the time of publication there are no known conflicts between this specification, cited regulations, and the normative references in 2.1.1 for 2013 HD OBD regulations. Cited regulations take precedence over this specification and references in 2.1.1. Cited SAE specifications take precedence over this specification.

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J272   Vehicle Identification Number Systems

SAE J1939   Recommended Practice for a Serial Control and Communications Vehicle Network

SAE J1939-03   On Board Diagnostics Implementation Guide

SAE J1939-11   Physical Layer, 250K bits/s, Twisted Shielded Pair

SAE J1939-13   Off-Board Diagnostic Connector

SAE J1939-15   Reduced Physical Layer, 250K bits/sec, Un-Shielded Twisted Pair (UTP)

SAE J1939-21   Data Link Layer

SAE J1939-71   Vehicle Application Layer (Through February, 2009)

SAE J1939-73   Application Layer—Diagnostics

SAE J1939-81   Network Management

SAE J2403   Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature

2.2   Related Publications

The following publications are for information purposes only and are not a required part of this SAE Technical Report.

2.2.1   SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1699®-3   Vehicle OBD II Compliance Test Cases

2.2.2   ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 3779:2009   Road vehicles - Vehicle identification number (VIN) - Content and structure

2.2.3   Other Publications

2.2.3.1   ARB Regulations

Available from California Environmental Protection Agency Air Resources Board, 1001 "I" Street, P.O. Box 2815, Sacramento, CA 95812, Tel: 916-322-2990, <http://www.arb.ca.gov/msprog/obdprog/obdregs.htm>.

13 CCR 1968.2 – Title 13, California Code Regulations, Section 1968.2, Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II)

13 CCR 1971.1 – Title 13, California Code Regulations, Section 1971.1, On-Board Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines (HD OBD)

NOTE: See SAE J1939-73 Section 2 and Table 2 for a full list of ARB, European, and US EPA OBD regulations supported by SAE J1939-73.

2.2.3.2   ATA Technology and Maintenance Council [TMC] Recommended Practices:

Available from the American Trucking Associations [ATA] at www.atabusinesssolutions.com.

TMC RP1210 B Windows™ Communication API

NOTE: Windows™ is a trademark of Microsoft Corporation.

3. DEFINITIONS

The definitions provided in SAE J2403 apply to this document as applicable.

3.1   Definition of Terms

Failure – Results from running a test are flagged as failed by the Test Computer.

Test Computer or Test Tool – Equipment used to generate and monitor tests and messages.

Warning – Results from running a test are flagged for further analysis by the Test Computer operator.

Additional definitions of terms that are related to the use of this document may be found in the publications listed under 2.1.

3.2   Acronyms

The following are common acronyms used in this document:

ARB   Air Resources Board

CAL ID   Calibration Identification

CAN   Controller Area Network

CCM   Comprehensive Component Monitoring

CVN   Calibration Verification Number

DTC   Diagnostic Trouble Code

ECM   Engine Control Module

ECU   Electronic Control Unit

EPA   Environmental Protection Agency

HD OBD   Heavy-Duty On Board Diagnostics

HEV   Hybrid Electric Vehicle

ID   Identification (number)

ISO   International Standards Organization

MIL   Malfunction Indicator Lamp

NVRAM   Non-Volatile Random Access Memory

OBD II   On Board Diagnostics (level 2)

PVE   Production Vehicle Evaluation

SA   Source Address (see SAE J1939-21)

SAE   Society of Automotive Engineers

TID   Test Identifier (See SAE J1939-73 DM7)

VIN   Vehicle Identification Number

4. OVERVIEW

The purpose of the test procedures given in Sections 6 and 7 is to demonstrate that diagnostic communications with the vehicle and/or component can be established and sustained, according to the SAE J1939 protocol for the diagnostic services required by established OBD regulations. The demonstration shows that the communications implemented on the vehicle adhere to the structure defined and provide data, which can be interpreted using the information contained in the SAE J1939-73, SAE J1939-71, and other referenced documents. SAE J1939-73 defines emission-related diagnostic services and indicates in Tables 1 and 2 which services are required for the given regulations.

These test procedures demonstrate the interface provided by the vehicle's OBD diagnostic connector as shown in Figure 1 below. The test results provide evidence that the integration of the engine into the vehicle does not interfere with required diagnostic capabilities. The diagnostic connector is defined in SAE J1939-13. It will be located and labeled according to HD OBD regulations. Test requirements of Section 6 are focused on Production Vehicle Evaluation [PVE] requirements given in 13 CCR 1971.1 (l)(1) Verification of Standardized Requirements. Test requirements in Section 7 are focused on OBD regulations that preceded 13 CCR 1971.1.

Figure 1 abstracts a SAE J1939 network on the vehicle, which comprises the system under test. The network is exercised by the test computer using a compatible CAN interface for SAE J1939 communications. The test computer and the vehicle's SAE J1939 network exchange data using the vehicle's SAE J1939-13 connector. The test computer requests SAE J1939-73 Diagnostic Messages and records the vehicle network's responses. These requests and responses target the required communication capabilities like those defined in 13 CCR 1971.1 (h) which documents the communication capabilities required for engines and contributing emissions related components. Since many legacy scan tools have relied upon TMC RP 1210B for their SAE J1939 Interfaces for diagnostic communications, use of an RP1210B API for PVE testing is highly desirable.
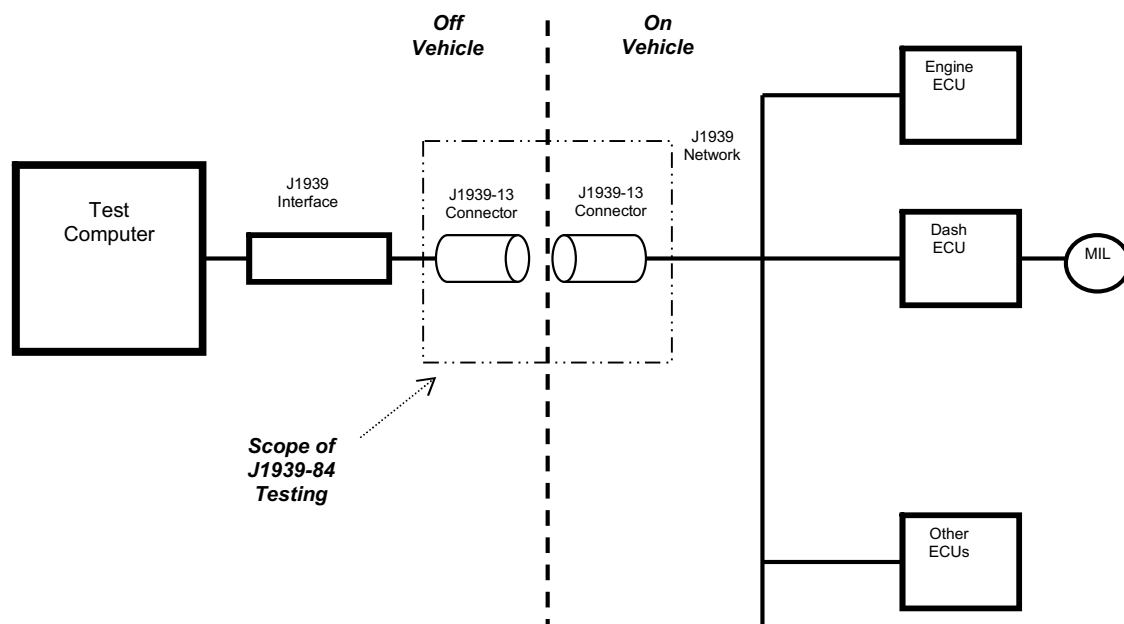
FIGURE 1 - SAE J1939-84 TEST SCOPE OVERVIEW

NOTE: The full title of section (l) in 13 CCR 1971.1 is "Production Engine/Vehicle Evaluation Testing." PVE, as Production Vehicle Evaluation, is the commonly used term (originally defined in light-duty OBD regulations) for testing diagnostic capabilities in completed production vehicles for both light duty vehicles and heavy-duty vehicles.

4.1   Limitations on Testing

Destructive tests cannot be defined to evaluate standardized communication capabilities as a part of PVE. Tests are designed for use at vehicle assembly plants on vehicles that will be delivered to customers, and not delivered to the vehicle or engine manufacturer, after the tests have been completed. Thus, testing cannot reduce the value of the vehicle, through damage to the vehicle or engine, or through its overuse. Commercial vehicles will not be driven at vehicle assembly plants for the tests defined in Sections 6 and 7.

4.2   Engine Specific Information Requirements

Engine manufacturers must identify which faults are recommended to provide content for diagnostic message responses that are demonstrated in Sections 6 and 7. Faults that are detected in a single ignition key cycle without driving the vehicle or running the engine are required. These recommendations must provide clear instructions for initiating the fault and its subsequent repair. Engine manufacturers must also identify an SPN, FMI and Test Identification combination that will provide an example of test results for a completed OBD diagnostic test – these test results must be available from an engine operating at its normal low idle speed. Finally, engine manufacturers must identify the J1939 source address(es) that shall participate in responses to queries.

4.3   Test Procedure Reuse

The procedures given in Sections 6 and 7 may have other applications beyond the specific purposes of PVE regulation testing. For example, they may be used to evaluate the integration of new components on the vehicle or engine. Adaptation of these procedures for other purposes is the responsibility of the user.

4.4   Document Overview

Section 5 discusses common test conditions, test planning, and communication capabilities for the test computer. Section 6 provides a test plan and test procedures for HD OBD vehicles, which are focused on 13 CCR 1971.1 (l)(1). Section 7 provides test procedures for Euro IV and Euro V vehicle testing.

5.   TEST CONDITIONS, TEST PLANNING, AND COMMUNICATION CAPABILITIES

This section discusses common test conditions for the vehicle and defines the measurement accuracy for the test computer.

5.1   Test Vehicle

Before testing, the test vehicle shall be free from any lingering manufacturing defects, and capable of use. The vehicle's engine, transmission, instrumentation, lighting, and brake systems shall be complete, operable, and free from known failures. The vehicle's battery shall be fully charged.

The plurality of non-OBD ECUs support DM1 and DM2 to convey non-emissions related diagnostic information. Since lingering DM2 faults can indicate an abnormal condition, vehicles with DM2 faults may not be ready to test. This may be particularly true of a recently produced vehicle where faults were cleared from each system by end of line processing.

NOTE: Vehicle manufacturers routinely screen vehicles for failures using DM1 and DM2 requests, where only those vehicles with no faults displayed in replies for both DM1 and DM2 are deemed 'ready to ship.' The HD OBD system will experience queries for DM2, and should tolerate them without performance deterioration.

5.2   Test Conditions

Tests shall be performed using a stationary vehicle under ambient temperatures between 10 and 35 °C. If the battery voltage falls below 12 V (or 24 V for a 24-V system), the battery system shall be recharged before testing continues.

Formal testing shall be conducted with the test equipment connected via the vehicle's SAE J1939 diagnostic connector.

5.3   Test Planning

The engine manufacturer and vehicle manufacturer shall agree on the test plan for the vehicle. This test plan must define:

- Desired Vehicle Configuration for testing – the desired vehicle model, engine displacement, engine family, transmission, brake, and other equipment selections for the test.

- Hot/Cold temperature soak conditioning – any limitations or guidelines for engine fluid temperatures, where a cold or hot soak could impact the data gathered from the OBD system based on monitoring conditions.

- Regulation to be tested – which OBD regulation and version is being tested?

- Test process selection – which test process model will be followed from the Section 6 or Section 7 choices?

- Specific DTCs for inquiry into test results – which DTCs will provide scaled test results showing a completed test where a diagnostic decision has been reached under the test conditions anticipated, where the vehicle will remain stationary in controlled environment?

- Methods recommended to induce single trip continuous component monitoring faults – which sensors are most likely to be readily accessible for the test technician to disconnect, and will be detected as failures within an efficient time frame?

- Distributed systems effects – what are the distributed elements of the emissions control system and its HD OBD monitoring system? Which elements provide independent support for HD OBD communication requirements?

- DM2 – Previously Active Diagnostic Trouble Codes approach. Must vehicles having DM2 faults be excluded from providing certification data? Do ECU(s) comprising the OBD system also support DM2? Which, if any, emissions related DTCs may also be reported using DM2 during the test procedure?

5.3.1   Tailoring for Distributed Systems

The engine manufacturer shall identify the assigned functions and anticipated source addresses for those devices which must be evaluated besides SA 0, function 0 (engine). Subsection 6.10 discusses additional tailoring considerations for the HD OBD test procedure.

5.3.2   Tailoring considerations for Regulatory Content

These procedures have been designed to the requirements given in the most current version of the regulations. Section 6 has been developed for use with systems supporting HD OBD. The procedures may be adapted to earlier regulatory versions by omitting requests for SAE J1939-73 Diagnostic Messages and SAE J1939-71 Application Layer data that are not required by the earlier versions of the regulation. Careful analysis is required to complete such an adaptation. Tables 1 and 2 of SAE J1939-73 will provide much of the guidance needed to tailor Section 6 or Section 7 procedures to prior regulatory regimens.

5.3.3   Tailoring Considerations on the Use of DM2 by the OBD System ECU(s)

Formal testing will be conducted on a production vehicle containing no faults with the test equipment connected via the SAE J1939 diagnostic connector. When tests are conducted on vehicles with faults, test results must be interpreted with care to assure that the failure conditions do not impact the results. Additional faults will increase the number of DTCs contained in results and require a search for the expected DTC among them.

5.3.4   Tailoring for Use During Component and/or Vehicle Developmental Testing

Demonstration of performance standards prior to production is commonplace as a part of verification and validation test planning. When tests are exercised under development conditions, where initial conditions, performance sequence, or other complete vehicle assumptions may not be satisfied, it is the responsibility of the test user to tailor the procedure and interpret the results based on the actual test conditions. Formal testing shall follow the sequence provided in this document.

5.4   Test Computer Communication Capabilities

5.4.1   Hardware Interface

The test computer hardware interface to the vehicle shall follow the hardware interface provisions given for CAN as documented in SAE J1939-11 and SAE J1939-15. The connection to the vehicle shall comply with SAE J1939-13.

5.4.2   Software Interface

The test computer software interface to the hardware interface may comply with TMC RP 1210B.

5.4.3   Message Format

The message format is defined in SAE J1939-21, SAE J1939-73, and SAE J1939-71.

5.4.4   Message Timing

The test computer shall be capable of measuring the response time to an accuracy of at least 1 ms. The message response timing is specified in SAE J1939-21.

5.4.5   Throughput Capacity

The test computer shall be capable of sustaining repeated bursts of 100% bus utilization in excess of 500 ms without loss of a single CAN frame in the captured and stored data. Message timing requirement shall be met for all burst data collected.

5.4.6   Storage Capacity

The test computer shall be capable of storing all the CAN frames transmitted by the vehicle for subsequent analysis.

6.   HD OBD TEST PLAN AND PROCEDURES

Table 1 provides a summary test plan for PVE testing of assembled vehicles at Vehicle Assembly Plants as defined for 13 CCR 1971.1 (l)(1). The goal of this testing is to demonstrate that the standardized communications required in section (h) of 13 CCR 1971.1 are not compromised in the assembled vehicle. This testing is limited by the Vehicle Manufacturer's ability to exercise the vehicle's drive cycle in a vehicle repair stall, and the limited amount of fuel provided in newly assembled vehicles prior to consignment to shipping marshalling yards. Communications are assessed, under these constraints with the engine off and with the engine running. Operation of the OBD system is demonstrated using single drive cycle Comprehensive Component Monitoring (CCM) faults recommended by the engine manufacturer.

Table 1 identifies nine test sections for PVE testing, explaining the test objectives for each step. These test sections are provided in 6.1 through 6.9. Subsection 6.10 discusses distributed system effects on this plan. Testing begins with the vehicle in a key off engine off state. Engine running tests follow the engine off tests.

TABLE 1 - TEST PLAN FOR HD OBD PVE

Section	Section Objectives	Section Summary
I	*Vehicle Qualification – Key On Engine Off – No Faults*	*Verify Initial Conditions*
	Tests begin with a recently produced vehicle. The vehicle shall have all assembly defects removed.	Verify the engine control system configuration and demonstrate that all required data is provided while the engine is *not running*. Only vehicles with no active faults (DM1), no pending faults (DM6), and no confirmed faults (DM12) should proceed with Section II. The vehicle shall have exhibited the bulb check where MIL_Status was observed as off.
II	*Key On Engine Off – CCM Failure Stimulation*	*Verify Engine Off System Response to Fault.*
	Verify HD OBD system response to a CCM failure while the engine is not running. The engine manufacturer shall recommend circuits that can readily be disconnected while the engine is off to provide the failure stimulus for these tests.	The vehicle shall report the CCM failure according to 13 CCR 1971.1.
III	*Key On Engine Off – Clear CCM Failure*	*Verify Clear Fault System Response*
	Verify OBD system response to a clear fault command when the fault has not been corrected on the vehicle.	Responses should remain constant as fault still exists. The command to clear faults may complete, and temporarily show MIL_Status = Off. MIL_Status shall revert to ON, after the failure is again detected. The failure shall be reported using same services as displayed in Section II.
IV	*Key On Engine Off – Correct CCM Failure*	*Verify Behavior with Fault Removed*
	Verify OBD system response to the correction to the CCM fault.	The failure shall still be displayed in DM12, as three (drive) cycles have not yet occurred. The fault will not be seen in DM6 as pending faults must be deleted within 10 s [per 13 CCR 1971.1 (d)]
V	*Key On Engine Off – Clear CCM Failure*	*Verify System Behavior with Fault Removed*
	Verify OBD system response to a clear command, where the failure has been 'fixed.'	The system shall exhibit no faults, after the DM11 command has been acknowledged. All required data shall be capable of being provided. [CCM faults reported as permanent faults will be retained, as 3 drive cycles have not yet occurred to allow them to be cleared.] Systems that do not clear faults or provide other faults not related to the stimulus need not proceed with section VI.
VI	*Engine Running – No Faults*	*Verify System Operation with Engine Running*
	The same vehicle shall be used for both the engine off and the engine running sections of the test. The engine off sections shall be run prior to the engine running sections being run. Engine misfire monitoring at idle is suggested to demonstrate communication of test results using the test results for cylinder 1. The engine manufacturer shall confirm the SPN and FMI to be used to demonstrate test results.	Demonstrate that all required data is provided while the engine is *running.* Only vehicles with no active faults (DM1), no pending faults (DM6), and no confirmed faults (DM12) should proceed with Section VII.
VII	*Engine Running – Response to Fault Stimulus*	*Verify System Operation with Failure Stimulus*
	Verify OBD system responses with a fault present. A 'single' trip CCM fault recommended by the engine manufacturer shall be used. This fault shall not disable misfire monitoring at idle. Verify the engine provides data stream data with a fault present.	The engine shall report the CCM failure using DM1 and DM12. The failure may also be reported using DM28. The engine shall continue to provide supported broadcast and on request SPNs
VIII	*Engine Running – Correct CCM Failure*	*Verify System Response with Failure Removed*
	Verify the OBD system's response to the correction of the failure while the engine is running. The OBD system shall retain its ability to communicate all required information.	The failure shall still be displayed in DM12, as three (drive) cycles have not yet occurred, and MIL_status shall remain ON. The fault may be retained in DM6 as no drive cycle has yet been completed. Systems recording CCM faults as permanent faults shall retain the display of the fault in DM28.
IX	*Engine Off – Verify Engine Running Fault Clears*	*Verify fault can be cleared after engine off*
	Turn engine off and wait 2 min before starting step 1 of section IX. The wait time provides an opportunity for the ECM to complete off-line activities, prior to being exercised when the key is turned back to on from off.	Verify failure that occurred while the engine was running can be cleared and that all required communications are provided. A wait time is provided to allow for ECM background tasks. For those systems that do not accept DM11 while the engine is running, the failure will be displayed in DM1. It shall continue to be displayed in DM12 (and DM28, if previously recorded as permanent) as three drive cycles have not been recorded. After being cleared, it may only be displayed in DM28.

Individual requests in the procedures below are shown as having either a global address, indicated by [G], or a destination specific request, indicated by [D]. Destination specific requests will typically be sent to those OBD ECUs that respond to a global request for DM5. All responses provided during developmental testing are subject to 5.3.4.

6.1   Test Procedure Section I Vehicle Qualification

Tests begin with a recently produced vehicle selected according to the regulations for its configuration. The vehicle shall have all assembly defects removed. Verify the engine control system configuration and demonstrate that all required data is provided while the engine is not running. The vehicle qualification test procedure confirms that the initial conditions for assessing vehicle OBD communications are met by the selected vehicle. Vehicle with faults introduced as a part of the assembly process do not provide a reasonable starting condition, because they require repairs unknown to the process in order to clear their 'arbitrary' faults. Any faults observed during section I shall be consistent with the test plan for the vehicle. Ideally, only vehicles that have no active (DM1), pending (DM6), or confirmed (DM12) faults will proceed with the subsequent test sections when data for a PVE (I)(1) submission is collected. The vehicle is also qualified by confirming that the OBD communications software is proper by evaluating HD OBD Compliance (DM5), CAL ID/CVN (DM19) and VIN (VI). Finally, the ability of a tool to properly connect to the vehicle and its HD OBD communications is confirmed.

TABLE 2 - VEHICLE QUALIFICATION TEST PROCEDURE

§I Step	Stimulus/Response	Test Step Objective
§I	*Vehicle Qualification – Key On Engine Off – No Faults*	*Verify Initial Conditions.*
1	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status = Off during the bulb check period.
2	Address Claim (See Figure A.6, SAE J1939-81)	Request Addresses and Names in use by network.
3	ECU#X Response Address Claim (NAME)	Receive network responses. Identify address for function 0. If function 0 is not provided, assume SA 0 is the engine.
4	Claim Address 250 or 249	Claim an off-board tool address.
5	Diagnostic Readiness 1 (DM5) Request Message [G]	Verify OBD_Compliance defines the engine as an HD OBD Engine.
6	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	At least one response shall indicate compliance to HD OBD. The SA of function 0 shall indicate compliance.
7	Calibration Information (DM19) Request Message [G]	Verify that CAL ID matches the test request.
8	ECU#X Response: Calibration Information (DM19) Response Message	CAL ID and CVN shall match test request.
9	VIN Request Message [G]	Verify Vehicle VIN.
10	ECU#X Response: VIN (VI) Message (PGN 65260)	VIN provided shall match door jam plate and test request
11	Clear Active Diagnostic Codes (DM11) Request Message [D]	Clear faults prior to subsequent test steps.
12	ECU#X Response: Acknowledge Message	Requests to clear faults shall be accepted for engine off conditions.
13	Active Emissions- Related Faults (DM12) Request Message [G]	Verify there are no active emissions-related faults.
14	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	Stop testing and repair vehicle if any faults are observed.
15	Pending Emissions- Related Faults (DM6) Request Message [G]	Verify there are no pending faults.
16	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	Stop testing and repair vehicle if any faults are observed.
17	Previously Active Emissions Related DTCs (DM23) Request Message [G]	Verify there are no previously active emissions related faults.
18	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	Stop testing and repair vehicle if any faults are observed.
19	Permanent DTCs (DM28) Request Message [G]	Verify there are no permanent faults.
20	ECU#X Response: Permanent DTCs (DM28) Response Message	Note any permanent faults received in the test log.
21	ECU#X Active DTCs (DM1) Broadcast Message	Verify there are no active faults.
22	DTC Counts (DM29) Request Message [G]	Verify DTC counts match prior display messages. [All are expected to be zero.]
23	ECU#X Response: DTC Counts (DM29) Response Message	[Record counts in test log.]
24	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	Verify Active and Previously active counts in DM5 are zero. Verify supported monitors are not ready. [CCM may be reported as ready.]
25	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	
26	SPN Supported For Freeze Frame And Data Stream (DM24) Request Message [D]	Request supported Freeze Frame and broadcast data.
27	ECU#X Response: SPN Supported (DM24) Response Message	[Record SPN support in test log.]
28	Expanded Freeze Frame (DM25) Request Message	Verify that the freeze frame is empty.
29	ECU#X Response: Expanded Freeze Frame (DM25) Response Message [D]	[An empty freeze frame should be conveyed.]

§I Step	Stimulus/Response	Test Step Objective
30	ECU#X Supported Broadcast Data Confirmation	Confirm availability of supported broadcast data.
31	On Request PGN Request Message	Confirm available of on request data.
32	ECU#X Response: On Request PGN [D]	
33	Diagnostic Readiness 2 (DM21) Request Message	Verify distances and times are zero.
34	ECU#X Response: Diagnostic Readiness 2 (DM21) Message [G]	
35	Diagnostic Readiness for This Trip (DM26) Request Message [G]	Verify supported monitors are not ready. [CCM may be reported as ready.]
36	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	
37	Command Non-Continuously Monitored Test (DM7) Request Message (TID = 247) [D]	Select an SPN having test data support from the DM24 display and query for test results using the selected SPN.
38	ECU#X Response: Scaled Test Results (DM30)	Verify test results are not available for all tests for the selected SPN. [See SAE J1939-73 Table 6 row 3.]
39	Command Non-Continuously Monitored Test (DM7) Request Message (TID = 250) [D]	Select an SPN and FMI from those displayed in the previous response.
40	ECU#X Response: Scaled Test Results (DM30)	Verify test results are not available for an individual test.
41	Monitor Performance Ratio (DM20) Request Message [G]	Verify response data is properly formatted.
42	ECU#X Response: Monitor Performance Ratio (DM20)	
43	Emission Increasing- AECD Active Time (DM33) Request Message [D]	Verify response data is properly formatted.
44	ECU#X Response: Emission Increasing- AECD Active Time (DM33)	[Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
45	NTE Status (DM34) Request Message [G]	Verify properly formatted response provided.
46	ECU#X Response: NTE Status (DM34) Message	
	Notes: [G] A global request shall be used for the indicated PGN. [D] One or more destination specific request(s) shall be used for that (those) ECU(s) responding to a global request for DM5.	

6.2   Test Procedure Section II Key On Engine Off – CCM Failure Stimulation

Section II verifies HD OBD system response to a CCM failure while the engine is not running. The circuit continuity fault stimulus is provided on a parked vehicle where the vehicle has not been started. Step 1 assumes that the circuit continuity fault recommended by the engine manufacturer has been introduced and matured. It is suggested that the fault will mature within 5 min. This procedure also assumes that key steps in section I have been completed to assure the vehicle state is appropriate for PVE (13 CCR 1971.1 (l)(1)) testing. The vehicle shall report the CCM failure according to 13 CCR 1971.1 and SAE J1939-73.

The engine manufacturer shall recommend circuits that can readily be disconnected while the engine is off to provide the failure stimulus for these tests.

TABLE 3 - KEY ON ENGINE OFF – CCM FAILURE STIMULATION

§II Step	Stimulus/Response	Test Step Objective
§II	*Key On Engine Off – CCM Failure Stimulation*	*Verify Engine Off System Response to Fault.*
1	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status = On. [Allow at least 5 min (or a shorter the time recommended by the manufacturer) for the fault to mature.]
2	Diagnostic Readiness 1 (DM5) Request Message [G]	Collect SA for destination specific requests.
3	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	Iterate multiple responses for subsequent destination specific requests.
4	Active Emissions- Related Faults (DM12) Request Message [D]	Retrieve the confirmed fault indicated by MIL_Status = On.
5	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	Record the DM12 content to compare with later DM1 results. Compare the confirmed fault provided with the manufacturer's recommendation.
6	Pending Emissions- Related Faults (DM6) Request Message [D]	Verify there are no (or one) pending faults. [13 CCR 1971.1 (d)(2.2.2)(B) requires deletion of pending faults in 10 s]
7	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	[Note: Systems that erase the pending fault when the fault is detected as confirmed will provide SPN 0, FMI 0 and OC 0. Some Federal HD OBD systems may retain their pending fault for subsequent deletion.]
8	Previously Active Emissions Related DTCs (DM23) Request Message [D]	Verify there are no previously active faults.
9	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	The system will return no faults for DM23. [Note: The ECU shall not NACK the step 8 request; as a convention is defined for positive responses for all fault code requests.]
10	Permanent DTCs (DM28) Request Message [D]	Verify that a permanent fault is set.
11	ECU#X Response: Permanent DTCs (DM28) Response Message	The confirmed fault shall also be displayed as a permanent fault, (when set for CCM faults).
12	ECU#X Active DTCs (DM1) Broadcast Message	Verify Active fault provided matches DM12 results.
13	DTC Counts (DM29) Request Message [D]	Verify DTC counts. [Typically, one or zero DTCs]
14	ECU#X Response: DTC Counts (DM29) Response Message	
15	DTC Counts / Diagnostic Readiness (DM5) Request Message [D]	Verify the Active and Previously Active Counts.
16	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	There should be 1 active fault and no previously active faults.
17	SPN Supported For Freeze Frame And Data Stream (DM24) Request Message [D]	Verify support with faults present. [This should provide the same response as test section I.]
18	ECU#X Response: SPN Supported (DM24) Response Message	
19	Expanded Freeze Frame (DM25) Request Message [D]	Verify freeze frame (if provided for CCM fault).
20	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	The freeze frame shall display the sole CCM fault.
	Notes: [G] A global request shall be used for the indicated PGN. [D] One or more destination specific request(s) shall be used for that (those) ECU(s) responding to a global request for DM5.	

6.3   Test Procedure Section III Key On Engine Off – Clear CCM Failure

Section III attempts to clear an unrepaired fault. This will verify OBD system response to a clear fault command when the fault has not been corrected on the vehicle. It is expected that the fault will still be observed in all the same messages as it was observed in section II. The command to clear faults may complete, and temporarily show MIL_Status = Off. MIL_Status shall revert to ON, after the failure is again detected. The failure shall be reported using the same services as displayed in section II.

TABLE 4 - KEY ON ENGINE OFF – CLEAR CCM FAILURE TEST PROCEDURE

§III Step	Stimulus/Response	Test Step Objective
§III	*Key On Engine Off – Clear CCM Failure*	*Verify Clear Fault System Response. [Responses should remain as fault still exists.]*
1	Clear Active Diagnostic Codes (DM11) Request Message [D]	
2	ECU#X Response: Acknowledge Message	Implementation dependent, an ECU may NACK the 'uncleared' fault, as a failed operation.
3	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status = On. [MIL may remain off for a brief period of time.]
4	Diagnostic Readiness 1 (DM5) Request Message [D]	Verify the active fault count. Verify there are no previously active faults.
5	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	
6	Active Emissions- Related Faults (DM12) Request Message [G]	Verify the confirmed fault is retained.
7	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	
8	Pending Emissions- Related Faults (DM6) Request Message [G]	Verify there are no (or one) pending faults.
9	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	[Note: 13 CCR 1971.1 (d)(2.2.2)(B) requires J1939 implementations to delete pending faults in 10 s. Federal regulations allow more time.]
10	Previously Active Emissions Related DTCs (DM23) Request Message [G]	Verify there are no previously active emissions related faults.
11	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	
12	Permanent DTCs (DM28) Request Message [G]	Verify a permanent fault is set (if set for CCM faults).
13	ECU#X Response: Permanent DTCs (DM28) Response Message	
14	DTC Counts (DM29) Request Message [G]	Verify DTC counts. [Typically, one or zero DTCs].
15	ECU#X Response: DTC Counts (DM29) Response Message	
16	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	Verify active and previously active counts.
17	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	
18	Diagnostic Readiness 2 (DM21) Request Message [G]	Verify times and distances.
19	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	[All values will be zero after a DM11. Time Since Diagnostic Trouble Codes Cleared may display the minutes since step 1.]
20	Diagnostic Readiness for This Trip (DM26) Request Message [G]	Verify support with faults present. [This should result in the same response as section II.]
21	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	
22	Expanded Freeze Frame (DM25) Request Message [D]	Verify freeze frame (if provided for CCM fault). [This should result in same response as section II.]
23	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	
	Note: [G] A global request shall be used for the indicated PGN. [D] One or more destination specific request(s) shall be used for that (those) ECU(s) responding to a global request for DM5.	

6.4   Test Procedure Section IV Key On Engine Off – Correct CCM Failure

Section IV assesses the OBD system response, after the CCM failure introduced during Section II has been corrected. The failure shall still be displayed in DM12, as three (drive) cycles have not yet occurred. Some Federal HD OBD implementations may retain the fault in DM6 as no drive cycle has yet been completed that may trigger end of drive cycle 'bookkeeping' for HD OBD information.

TABLE 5 - KEY ON ENGINE OFF – CORRECT CCM FAILURE TEST PROCEDURE

§IV Step	Stimulus/Response	Test Step Objective
§IV	Key On Engine Off – Correct CCM Failure	Verify Behavior with Fault Removed.
1	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status = On. [MIL should be latched for 3 cycles.]
2	Active Emissions- Related Faults (DM12) Request Message [D]	Verify DM12 retains fault.
3	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	
4	Pending Emissions- Related Faults (DM6) Request Message [D]	Verify there are no (or one) pending faults. [No pending faults per 13 CCR 1971.1 (d)(2.2.2)(B)]
5	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	['No pending faults' assumes a 1 trip strategy. Federal regulations allow for more time than (d)(2.2.2(B).]
6	Previously Active Emissions Related DTCs (DM23) Request Message [D]	Verify there are no previously active faults.
7	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	
8	Permanent DTCs (DM28) Request Message [D]	Verify the permanent fault set (if set for CCM faults).
9	ECU#X Response: Permanent DTCs (DM28) Response Message	
10	DTC Counts (DM29) Request Message [D]	Verify DTC counts match fault returns.
11	ECU#X Response: DTC Counts (DM29) Response Message	
12	DTC Counts / Diagnostic Readiness (DM5) Request Message [D]	Verify DTC counts match fault returns.
13	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	
14	Expanded Freeze Frame (DM25) Request Message [D]	Verify freeze frame, if provided for CCM fault.
15	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	
16	Diagnostic Readiness 2 (DM21) Request Message [D]	Verify times and distances.
17	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	[Distances will not increase on a stationary vehicle. Time Since Diagnostic Trouble Codes Cleared may display the minutes since step 1 of Section III.]
18	Diagnostic Readiness for This Trip (DM26) Request Message [D]	Verify Readiness Response.
19	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	[This should result in the same response given in the Section III.]
20	Command Non-Continuously Monitored Test (DM7) Request Message [D]	Request Test Results [There should still be no results for an 'engine running' test.]
21	ECU#X Response: Scaled Test Results (DM30)	
	Note: [G] A global request shall be used for the indicated PGN. [D] One or more destination specific request(s) shall be used for that (those) ECU(s) responding to a global request for DM5.	

6.5   Test Procedure Section V Key On Engine Off – Clear CCM Failure

Section V uses the clear fault messages to reset the diagnostic status, after the fault has been repaired. This verifies OBD system response to a clear command, where the failure has been 'fixed.' The system shall exhibit no faults, after the DM11 command has been acknowledged. All required data shall be provided. CCM faults reported as permanent faults will be retained, as 3 drive cycles have not yet occurred to allow them to be cleared. Systems that do not clear faults or provide other faults not related to the stimulus need not proceed with section VI.

TABLE 6 - KEY ON ENGINE OFF – CLEAR CCM FAILURE TEST PROCEDURE

§V Step	Stimulus/Response	Test Step Objective
§V	**Key On Engine Off – Clear CCM Failure**	**Verify System Behavior with Fault Removed**
1	Clear Active Diagnostic Codes (DM11) Request Message [G]	Fault should clear after having been repaired.
2	ECU#X Response: Acknowledge Message	No acknowledge message for global request
3	Active Emissions- Related Faults (DM12) Request Message [G]	Verify there are no active emissions related faults.
4	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	
5	Pending Emissions- Related Faults (DM6) Request Message [G]	Verify there are no pending faults.
6	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	[There should be no pending faults after a clear request.]
7	Permanent DTCs (DM28) Request Message [G]	Verify one (or no) permanent fault.
8	ECU#X Response: Permanent DTCs (DM28) Response Message [G]	[The permanent fault will be retained as no drive cycles have been completed.]
9	Previously Active Emissions Related DTCs (DM23) Request Message [G]	Verify there are no previously active faults.
10	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	
11	ECU#X Active DTCs (DM1) Broadcast Message	Verify there are no active faults.
12	DTC Counts (DM29) Request Message [G]	Verify fault counts are zero.
13	ECU#X Response: DTC Counts (DM29) Response Message	[Permanent fault count will equal 1 as no drive cycles have occurred.]
14	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	Verify fault counts are zero.
15	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	
16	Expanded Freeze Frame (DM25) Request Message	Verify freeze frame data is empty.
17	ECU#X Response: Expanded Freeze Frame (DM25) Response Message [D]	
18	ECU#X Supported Broadcast Data Confirmation	
19	On Request PGN Request Message [D]	Confirm availability of on request data.
20	ECU#X Response: On Request PGN	
21	Diagnostic Readiness 2 (DM21) Request Message [G]	Verify times and distances are zero.
22	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	
23	Diagnostic Readiness for This Trip (DM26) Request Message [G]	Verify all monitors are not ready. [CCM may be reported as ready.]
24	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	
25	Command Non-Continuously Monitored Test (DM7) Request Message	Verify test results are not provided after fault is cleared.
26	ECU#X Response: Scaled Test Results (DM30)	
27	Monitor Performance Ratio (DM20) Request Message [D]	Verify response data is properly formatted.
28	ECU#X Response: Monitor Performance Ratio (DM20)	
29	Emission Increasing- AECD Active Time (DM33) Request Message [D]	Verify response data is properly formatted.
30	ECU#X Response: Emission Increasing- AECD Active Time (DM33)	[Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
31	NTE Status (DM34) Request Message [G]	Verify response data is properly formatted.
32	ECU#X Response: NTE Status (DM34) Message	
	Note:[G] A global request shall be used for the indicated PGN. [D] One or more destination specific request(s) shall be used for that (those) ECU(s) responding to a global request for DM5.	

6.6   Test Procedure Section VI Engine Running No Faults

Section VI begins the demonstration of communications with the engine running. The same vehicle shall be used for both the engine off and the engine running sections of the test. The engine off sections shall be run prior to the engine running sections being run. Engine misfire monitoring at idle is suggested to demonstrate communication of OBD diagnostic test results using the results for cylinder 1. The engine manufacturer shall confirm the SPN and FMI to be used to demonstrate test results. The engine manufacturer may recommend another monitor along with its SPN and FMI to provide monitor completion and test results. Only vehicles with no active faults (DM1), no pending faults (DM6), and no confirmed faults (DM12) should proceed with Section VII.

TABLE 7 - START ENGINE TEST PROCEDURE

§VI Step	Stimulus/Response	Test Step Objective
§VI	*Engine Running – No Faults*	*Verify System Operation with Engine Running.*
1	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status = Off, with engine running.
2	Diagnostic Readiness 1 (DM5) Request Message [G]	Verify OBD_Compliance defines the engine as an HD OBD engine.
3	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	Verify fault counts are zero.
4	Calibration Information (DM19) Request Message [D]	Verify CAL ID.
5	ECU#X Response: Calibration Information (DM19) Response Message	The same result as given in section I shall be displayed.
6	VIN Request Message [G]	Verify Vehicle VIN.
7	ECU#X Response: VIN Message	[The same result as given in section I shall be displayed.]
8	Clear Active Diagnostic Codes (DM11) Request Message [D]	Clear faults: engine may choose to NACK, when the engine is running.
9	ECU#X Response: Acknowledge Message	
10	Active Emissions- Related Faults (DM12) Request Message [G]	Verify there are no emissions active faults.
11	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	No active emissions related faults shall be displayed.
12	Pending Emissions- Related Faults (DM6) Request Message [G]	Verify there are no pending faults.
13	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	No pending faults shall be displayed.
14	Previously Active Emissions Related DTCs (DM23) Request Message [G]	Verify there are no previously active emissions related faults.
15	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	No previously active emissions related faults shall be displayed.
16	Permanent DTCs (DM28) Request Message [G]	Verify there are no (or one) permanent faults.
17	ECU#X Response: Permanent DTCs (DM28) Response Message	One permanent fault may be displayed. The fault displayed shall be the same one given in section II.
18	ECU#X Active DTCs (DM1) Broadcast Message	Verify there are no active faults
19	DTC Counts (DM29) Request Message [G]	Verify DTC counts match prior display messages. (All are expected to be zero)
20	ECU#X Response: DTC Counts (DM29) Response Message	[Record fault counts in the test log.]
21	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	Verify active and previously active counts in DM5 are zero. Verify supported monitors are not ready (CCM may be reported as ready.)
22	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	
23	SPN Supported For Freeze Frame And Data Stream (DM24) Request Message [D]	Request supported SPNs for freeze frame and broadcast data.
24	ECU#X Response: SPN Supported (DM24) Response Message	The same SPNs supported during section I shall be supported with the engine running.
25	Expanded Freeze Frame (DM25) Request Message [D]	Verify that the freeze frame is empty.
26	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	
27	ECU#X Supported Broadcast Data Confirmation	Confirm availability of supported broadcast data.
28	On Request PGN Request Message [D]	Confirm availability of on request data.
29	ECU#X Response: On Request PGN	
30	Diagnostic Readiness 2 (DM21) Request Message [G]	Verify distances and times are zero.
31	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	
32	Diagnostic Readiness for This Trip (DM26) Request Message [G]	Verify supported monitors are not ready. [CCM may be reported as ready.]
33	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	

§VI Step	Stimulus/Response	Test Step Objective
34	Command Non-Continuously Monitored Test (DM7) Request Message [D]	Verify test results are not available.
35	ECU#X Response: Scaled Test Results (DM30)	
36	Monitor Performance Ratio (DM20) Request Message [G]	Verify response data is properly formatted.
37	ECU#X Response: Monitor Performance Ratio (DM20)	
38	Emission Increasing- AECD Active Time (DM33) Request Message [D]	Verify response data is properly formatted.
39	ECU#X Response: Emission Increasing AECD Active Time (DM33)	[Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
40	NTE Status (DM34) Request Message [G]	Verify response data is properly formatted.
41	ECU#X Response: NTE Status (DM34) Message	
	Note: [G] A global request shall be used for the indicated PGN. [D] One or more destination specific request(s) shall be used for that (those) ECU(s) responding to a global request for DM5.	

6.7 Test Procedure Section VII Engine Running – Response to Fault Stimulus

Test section VII verifies OBD system responses with a fault present, while the engine is running. A 'single' trip CCM fault recommended by the engine manufacturer shall be used. This fault should not disable misfire detection during idle, unless an alternate test is used for display of test results. Verify the engine provides data stream data with a fault present. The engine shall report the CCM failure using DM1 and DM12. The failure may also be reported using DM6 and DM28. The engine shall continue to provide supported broadcast and on request SPNs.

TABLE 8 - ENGINE RUNNING – RESPONSE TO FAULT STIMULUS TEST PROCEDURE

§VII Step	Stimulus/Response	Test Step Objective
§VII	*Engine Running – Response to Fault Stimulus*	*Verify System Operation with Failure Stimulus.*
1	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status = On.
2	Diagnostic Readiness 1 (DM5) Request Message [G]	Collect SA for destination specific requests.
3	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	Iterate multiple responses for subsequent destination specific requests.
4	Active Emissions- Related Faults (DM12) Request Message [D]	Verify emissions active faults message.
5	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	
6	Pending Emissions- Related Faults (DM6) Request Message [D]	Verify no (or one) pending faults are provided. [Per 13 CCR 1971.1 (d) pending faults are deleted in 10 s.]
7	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	[Note: Erasure of the pending fault when the fault has been confirmed may likely result in no faults being returned. The key success criterion is the operation of the DM6 interface, and not status maintenance timing for erasing pending faults.]
8	Previously Active Emissions Related DTCs (DM23) Request Message [D]	Verify there are no previously active emissions related faults.
9	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	
10	Permanent DTCs (DM28) Request Message [D]	Verify there is one (or no) permanent fault(s).
11	ECU#X Response: Permanent DTCs (DM28) Response Message	[The permanent fault from section II may be displayed.]
12	ECU#X Active DTCs (DM1) Broadcast Message	Verify there is one active fault.
13	DTC Counts (DM29) Request Message [D]	Verify DTC counts match prior display messages.
14	ECU#X Response: DTC Counts (DM29) Response Message	All counts are expected to be one or zero.
15	DTC Counts / Diagnostic Readiness (DM5) Request Message [D]	Verify active and previously active counts in DM5 are one or zero. Verify supported monitors are not ready [CCM may be reported as ready.]
16	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	
17	SPN Supported For Freeze Frame And Data Stream (DM24) Request Message [D]	Request supported freeze frame and broadcast data.
18	ECU#X Response: SPN Supported (DM24) Response Message	
19	Expanded Freeze Frame (DM25) Request Message [D]	Verify that the freeze frame is empty for CCM fault.
20	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	[Note that the freeze frame may be empty for the CCM fault.]
21	ECU#X Supported Broadcast Data Confirmation	

§VII Step	Stimulus/Response	Test Step Objective
22	On Request PGN Request Message(s) [D]	Confirm on request data is available as given in DM24 response.
23	ECU#X Response: On Request PGN	
24	Diagnostic Readiness 2 (DM21) Request Message	Verify times are accumulating (non-zero).
25	ECU#X Response: Diagnostic Readiness 2 (DM21) Message [D]	[Minutes Run by Engine While MIL is Activated will show minutes since step 1 of Section VII. Time Since Diagnostic Trouble Codes Cleared may display the minutes since step 8 of section VI.]
26	Diagnostic Readiness for This Trip (DM26) Request Message	Verify supported monitors are not ready. [Misfire and CCM may be reported as ready.]
27	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	
28	Command Non-Continuously Monitored Test (DM7) Request Message [D]	Verify test results for Cylinder 1 misfire.
29	ECU#X Response: Scaled Test Results (DM30)	[An alternate test may be recommended by the engine manufacturer.]
30	Monitor Performance Ratio (DM20) Request Message [D]	Verify response data is properly formatted.
31	ECU#X Response: Monitor Performance Ratio (DM20)	
	Note: [G] A global request shall be used for the indicated PGN. [D] One or more destination specific request(s) shall be used for that (those) ECU(s) responding to a global request for DM5.	

6.8   Test Procedure Section VIII Engine Running Correct CCM Failure

Section VIII verifies the OBD system's response to the correction of the failure while the engine is running. Before this section is run, the stimulus that initiates the fault code observed in DM12 shall be corrected. This may be performed with the engine off. The OBD system shall retain its ability to communicate all required information. The failure shall still be displayed in DM12, as three (drive) cycles have not yet occurred, and MIL_Status shall remain ON. System recording CCM faults as permanent faults shall retain the display of the fault in DM28.

TABLE 9 - ENGINE RUNNING CORRECT CCM FAILURE TEST PROCEDURE

§VIII Step	Stimulus/Response	Test Step Objective
§VIII	*Engine Running – Correct CCM Failure*	*Verify System Response with Failure Removed.*
1	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status stays ON.
2	Active Emissions- Related Faults (DM12) Request Message [G]	Verify Fault Remains in DM12.
3	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	
4	Pending Emissions- Related Faults (DM6) Request Message [G]	Verify there are no pending faults.
5	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	
6	Permanent DTCs (DM28) Request Message [G]	Verify there is one (or no) permanent fault(s).
7	ECU#X Response: Permanent DTCs (DM28) Response Message	
8	Previously Active Emissions Related DTCs (DM23) Request Message [G]	Verify there are no previously active emissions related faults.
9	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message [G]	
10	ECU#X Active DTCs (DM1) Broadcast Message	Verify fault no longer appears in DM1.
11	DTC Counts (DM29) Request Message [G]	Verify DTC counts match fault receipts.
12	ECU#X Response: DTC Counts (DM29) Response Message	
13	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	Verify number of active and previously active faults match.
14	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	
15	Expanded Freeze Frame (DM25) Request Message [D]	Verify freeze frame data for fault if provided for CCM fault.
16	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	
17	Diagnostic Readiness 2 (DM21) Request Message [G]	Verify times remain non-zero.

§VIII Step	Stimulus/Response	Test Step Objective
18	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	[Minutes Run by Engine While MIL is Activated will show minutes since step 1 of Section VII. Time Since Diagnostic Trouble Codes Cleared may display the minutes since step 8 of section VI.]
19	Diagnostic Readiness for This Trip (DM26) Request Message [G]	Verify no monitors revert to 'not ready'.
20	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	
21	Command Non-Continuously Monitored Test (DM7) Request Message [D]	Check for test results for stationary misfire on cylinder 1 – if not provided the time before.
22	ECU#X Response: Scaled Test Results (DM30)	Test results should be provided.
23	Monitor Performance Ratio (DM20) Request Message [D]	Verify response data is properly formatted.
24	ECU#X Response: Monitor Performance Ratio (DM20)	
25	Emission Increasing- AECD Active Time (DM33) Request Message [D]	Verify response data is properly formatted.
26	ECU#X Response: Emission Increasing- AECD Active Time (DM33)	[Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
27	NTE Status (DM34) Request Message [G]	Verify response data is properly formatted.
28	ECU#X Response: NTE Status (DM34) Message	
	Note: [G] A global request shall be used for the indicated PGN. [D] One or more destination specific request(s) shall be used for that (those) ECU(s) responding to a global request for DM5.	

6.9   Test Procedure Section IX Engine Off – Verify Engine Running Fault Clears

Because an ECM is permitted to NACK a DM11 request while the engine is running, section IX provides for the fault to be cleared with the engine off after the engine running test sections. The engine shall be stopped, by turning the key off. Before initiating step 1, a wait time of 2 min shall be provided after turning the key on. A wait time is added to provide an opportunity for the ECM to complete off-line activities, prior to being exercised when the key is turned back to on from off.

Section IX verifies that the failure, which was recorded while the engine was running, can be cleared, and that all required communications are still provided. Two minutes is provided for off-line activities; the engine manufacturer shall identify any systems that require more than 2 min. For those systems that do not accept DM11 while the engine is running, the failure may be displayed in DM1 after the key has been turned back on. It shall continue to be displayed in DM12 (and DM28 if previously recorded as permanent) as three drive cycles have not been recorded. After being cleared, it will only be displayed in DM28.

After completion of section IX, the vehicle manufacturer may repeat process steps that he typically performs during the assembly of the vehicle to establish the VIN and record ECM status and content, prior to consigning the vehicle to the marshalling yard for shipment.

TABLE 10 - VERIFY ENGINE RUNNING FAULT CLEARS TEST PROCEDURE

§IX Step	Stimulus/Response	Test Step Objective
§IX	*Engine Off – Verify Engine Running Fault Clears*	*Verify fault can be cleared after engine off*
	Turn the engine off. Wait 2 min then turn ignition key back on and start step 1.	
1	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status stays ON, if DM11 is NACKed while the engine is running.
2	Active Emissions- Related Faults (DM12) Request Message [G]	Verify there are no emissions related faults reported, if DM11 was accepted while the engine was running.
3	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	
4	Pending Emissions- Related Faults (DM6) Request Message [G]	Verify there are no pending faults reported, as the failure was previously corrected.
5	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	
6	Permanent DTCs (DM28) Request Message	Verify there are no (or one) permanent faults reported.
7	ECU#X Response: Permanent DTCs (DM28) Response Message [G]	
8	Clear Active Diagnostic Codes (DM11) Request Message [D]	Clear faults. The system must ACK.
9	ECU#X Response: Acknowledge Message	

§IX Step	Stimulus/Response	Test Step Objective
10	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status is OFF.
11	Active Emissions- Related Faults (DM12) Request Message [D]	Verify there are no emissions related faults reported.
12	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	
13	Pending Emissions- Related Faults (DM6) Request Message [D]	Verify there are no pending faults reported.
14	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	
15	Permanent DTCs (DM28) Request Message [D]	Verify there are no (or one) permanent faults reported.
16	ECU#X Response: Permanent DTCs (DM28) Response Message	
17	Previously Active Emissions Related DTCs (DM23) Request Message [D]	Verify there are no previously active emissions related DTCs.
18	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	
19	ECU#X Active DTCs (DM1) Broadcast Message	Verify there are no active faults reported.
20	DTC Counts (DM29) Request Message [D]	
21	ECU#X Response: DTC Counts (DM29) Response Message	Verify DTC counts are zeros.
22	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	[The permanent fault count may equal 1.]
23	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify that the numbers of active and previously active faults are zero.
24	Expanded Freeze Frame (DM25) Request Message [D]	
25	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	Verify there are no freeze frame results.
26	ECU#X Supported Broadcast Data Confirmation	
27	Diagnostic Readiness 2 (DM21) Request Message [D]	Verify times and distances are reset to zero.
28	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	
29	Diagnostic Readiness for This Trip (DM26) Request Message [D]	Verify readiness is set to not ready.
30	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	
31	Command Non-Continuously Monitored Test (DM7) Request Message [D]	Verify there are no test results.
32	ECU#X Response: Scaled Test Results (DM30)	
33	Monitor Performance Ratio (DM20) Request Message [D]	Verify response data is properly formatted.
34	ECU#X Response: Monitor Performance Ratio (DM20)	
35	Emission Increasing- AECD Active Time (DM33) Request Message [D]	Verify response data is properly formatted.
36	ECU#X Response: Emission Increasing- AECD Active Time (DM33)	[Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
37	NTE Status (DM34) Request Message [D]	Verify response data is properly formatted.
38	ECU#X Response: NTE Status (DM34) Message	
	Note: [G] A global request shall be used for the indicated PGN. [D] One or more destination specific request(s) shall be used for that (those) ECU(s) responding to a global request for DM5.	

6.10 Application to Distributed Systems

Sections 6.1 through 6.9 describe tests that support a monolithic implementation model for the HD OBD system. Systems may be implemented in a distributed fashion, where more than one device may respond to a given diagnostic message request. Paragraphs 6.10.1 and 6.10.2 provide guidelines that adapt the procedures in 6.1 through 6.9 for distributed implementations. The steps are iterated among the separate ECUs. Such iteration shall be partitioned among engine off and engine running segments in the following ways:

6.10.1 Step-wise Parallel Evaluation of Components

Step-wise parallel evaluation iterates each test section step among all distributed system participants (ECUs) in turn for the given step. Thus for a three ECU system, all three ECUs are queried in turn as directed by the test step for destination specific requests, before the test procedure progresses with the next test step. The tests in 6.1 through 6.9 presume that distributed systems will be interrogated sequentially during each step and discuss collection of source addresses to be used as a part of the DM5 messages sent to the test computer.

6.10.2   Sequential Evaluation of Components

The procedures above are adapted for distributed systems by iteration among the separate modules. Such iteration may be sequenced among engine off and engine running segments in the following way:

1.   Execute section I once. Obtain CAL ID and CVN for each ECU in the distributed system.

2.   Iterate sections II through V for each ECU in the distributed system.

3.   Iterate sections VI through IX for each ECU in the distributed system.

Sequential evaluation of components may be better suited to those systems which are more loosely coupled and require disparate fault stimulation in order to be fully exercised. For sequential evaluation, a single trip CCM failure will be needed for each distributed ECU.

7.   TEST PROCEDURES FOR EURO IV AND EURO V

Section 7 discusses test procedures provided in the December 2008 revision for Euro IV and Euro V engines. Section 7.1 discusses testing with the engine off. Section 7.2 discusses testing with the engine running. Within each subsection, the Request and Response message data for each of the allowed protocols and test mode (service) that need to be conducted are defined. Evaluation criteria to judge success or failure are defined. Table 11 shows which services are tested under each operating condition.

NOTE: EU/UN/ECE regulations do not define or reference formal production vehicle evaluation requirements for Euro IV and V engines using SAE J1939. U.S. EPA regulations, which refer to SAE J1939 standards for standardized diagnostic communications before the adoption of HD OBD requirements, also do not define or reference formal production vehicle evaluation requirements for engines or vehicles. Retroactive application of these recommendations is not required by this recommended practice.

TABLE 11 - EURO IV/V CONDITIONS AND SERVICES TESTED

Section	Condition	Diagnostic Messages (DM)	Purpose
7.1 - 7.3	No Malfunctions	DM5, DM6, DM4, DM10, DM11, DM12, DM19, DM23	Basic test Service support
7.4 - 7.7	Pending Trouble Codes	DM4, DM6, DM24, DM25	DTC and status properly reported
7.8	Active Trouble Codes	DM12	Emission related DTCs

It is expected that formal testing will be conducted on a production vehicle containing no faults with the Test Computer connected via the SAE J1939-13 diagnostic connector. Formal testing will follow the order defined in this document.

The following notes are applicable to the component or vehicle testing described in this document:

a.   Battery voltage at the SAE J1939 connector pin must be between 11.0 and 32.0 V (i.e., nominal 12- or 24-V system with the engine off or the engine running).

b.   Multiple ECUs can respond to SAE J1939 request messages that are sent to the Global address.

c.   All data specified within messages are hexadecimal unless otherwise specified.

d.   XX = valid reported hexadecimal data (data not checked/specified in this document).

e.   Each OBD ECU will respond within the time defined in 5.2.

f.   The Test Computer will use the preferred addresses defined in SAE J1939 for a Diagnostic Tool.

g. Procedure to determine when the link drops out – Send SAE J1939 request for DM5. The proper response from all OBD ECUs will be verified or the diagnostic link will be flagged as being "down" and the test aborted.

h. It is assumed that all OBD emission or diagnostic-critical ECUs support DM5. Also, the number of emissions related ECUs are specified for the vehicle each with their CAL IDs and CVNs.

i. Multiple responses from a given ECU for a given request message shall be flagged as a warning. If a defined periodic message is received it should not be considered as a warning.

7.1   Compliance Test – No Malfunctions

This Section consists of a series of tests for evaluating the OBD compliance of the system under test. The purpose of these tests are to verify proper response behaviors of the OBD ECUs when there are no OBD, or emissions related failure conditions present.

7.1.1   Perform MIL Bulb Check, Engine Off

Purpose: This test determines that the MIL behaves as required by OBD legislation.

Procedure:

- Ignition off for at least 60 s. Connect Test Computer to the SAE J1939-13 connector.

- Turn ignition on. Do not crank engine.

Evaluation criteria:

- Visually verify that the MIL is on for a minimum of 15 s before proceeding. The MIL may remain illuminated for an indefinite amount of time until the engine is started.

7.1.2   Verify Communication, Ignition On, Engine Off

Purpose: To verify that the allowed protocol is supported and that at least one ECU on the vehicle sends a response message of the correct format. Also, to verify the number of responses match the number of emissions related components.

Procedure:

Test Computer sends SAE J1939 request message for DM5.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CE_{16}
Byte 2	(i.e., DM5 - PGN = 65230_{10}, $00FECE_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 2 - DIAGNOSTIC READINESS 1 (DM5) REQUEST MESSAGE

Message PGN:	65230 (DM5)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1-8	As defined for DM5 in SAE J1939-73 (Use OBD Type as defined.)	See DM5 definition

FIGURE 3 - ECU#X RESPONSE: DIAGNOSTIC READINESS 1 (DM5) RESPONSE MESSAGE

Evaluation criteria:

- Operator prompt 1 asks for the number of emission-related ECUs in the vehicle.

- The Engine ECU must be one of the responders to the DM5 request.

- The Test Computer shall record the different Source Addresses that provide the DM5 responses.

- If all of the predetermined emissions-related ECUs do not positively respond to the requested DM5 message, this shall be flagged as a failure. The value provided for OBD_Compliance shall indicate Euro IV or Euro V emissions.

7.1.3   Clear DTCs (DM11), Engine Off

Purpose: To verify that, with the ignition on and engine off, all ECUs provide the correct response to a SAE J1939 request for DM11.

Procedure:

- Transmit SAE J1939 request message for DM11 to each OBD compliant ECU and observe response message. The Test Computer will send a SAE J1939 Request message for DM11 to the devices that responded to DM5 as an OBD compliant device.

- Any Test Computer meeting these specifications must wait 2 s before proceeding to next step to allow for NVRAM read/write times.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	0 (Engine), other OBD compliant ECUs	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	$D3_{16}$
Byte 2	(i.e., DM11 - PGN = 65235_{10}, $00FED3_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 4 - CLEAR ACTIVE DIAGNOSTIC CODES (DM11) REQUEST MESSAGE

Message PGN:	59392 (ACK)	
Source Addr:	SA of Responding ECU	
Destination Addr:	255 (Global)	
Data:	**Data Description**	**Byte Value (Hex)**
Byte 1	0 for Faults Cleared (As defined for ACK in SAE J1939-21)	See ACK definition
Byte 2		FF_{16}
Byte 3		FF_{16}
Byte 4		FF_{16}
Byte 5	Source address of Test Computer	XX
Byte 6	PGN of requested message	$D3_{16}$
Byte 7	(i.e., DM11 - PGN = 65235_{10}, $00FED3_{16}$)	FE_{16}
Byte 8		00_{16}

FIGURE 5 - ECU#X RESPONSE: ACKNOWLEDGE MESSAGE

Evaluation criteria:

For each DM11 message sent to an OBD ECU, only that OBD ECU must respond with message as shown in the response in Figure 5. If any other OBD ECU responds to this diagnostic message, it shall be flagged as a failure.

7.1.4   Verify MIL Status Bit, Engine Off

Purpose: To verify the correct response to a SAE J1939 request for DM12, and that DTCs and the MIL status bit are not set.

Note to manufacturers: During bulb testing, MIL status bit must indicate whether the MIL will be illuminated after engine is started. It should not reflect the status of the MIL bulb driver circuit, which will be turning the bulb on for the bulb prove out.

Procedure:

- Test Computer sends SAE J1939 request message for DM12 to all OBD compliant ECUs. (Separate requests should be sent to each ECU by the Test Computer.)

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	0 (Engine), other OBD compliant ECUs	
Data:	**Data Description**	**Byte Value (Hex)**
Byte 1	PGN of requested message	$D4_{16}$
Byte 2	(i.e., DM12 - PGN = 65236_{10}, $00FED4_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 6 - ACTIVE EMISSIONS- RELATED FAULTS (DM12) REQUEST MESSAGE

Message PGN:	65236 (DM12)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	**Data Description**	**Byte Value (Hex)**
Byte 1-8	As defined for DM12 in SAE J1939-73 (should be Zero in bytes 3-6 to indicate no faults)	See DM12 definition

FIGURE 7 - ECU#X RESPONSE: ACTIVE EMISSIONS- RELATED FAULTS (DM12) RESPONSE MESSAGE

Evaluation criteria:

All OBD compliant ECUs must respond with a message as shown in the response in Figure 7. Responses are expected from all other OBD compliant ECUs on the vehicle. If the MIL status bit is not "off", a failure shall be flagged.

7.1.5   Check for Pending Diagnostic Codes (DM6) – Request On-Board Monitoring Test Results, Engine Off

Purpose: To verify that each ECU responds correctly to a DM6 request, and that the data in the responses are correct. Verify that there are no Pending Diagnostic Trouble Codes set since the clearing of Active Codes in the previous step.

Procedure:

- The Test Computer transmits the SAE J1939 Request message for DM6 to each OBD compliant ECU on the vehicle and confirms that there are no pending codes.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	0 (Engine), other OBD compliant ECUs	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CF_{16}
Byte 2	(i.e., DM6 - PGN = 65231_{10}, $00FECF_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 8 - PENDING EMISSIONS- RELATED FAULTS (DM6) REQUEST MESSAGE

Message PGN:	65231 (DM6)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1-8	As defined for DM6 in SAE J1939-73 (should be Zero in bytes 3-6 to indicate no faults)	See DM6 definition

FIGURE 9 - ECU#X RESPONSE: PENDING EMISSIONS- RELATED FAULTS (DM6) RESPONSE MESSAGE

Evaluation criteria:

- Verify that DM6 response received from all OBD compliant ECUs.

- Verify that emission-related faults have been cleared. Any fault code reported in this message indicates a current problem and should be flagged as a failure.

7.1.6   Verify Data Stream Information – Monitor Current Powertrain Diagnostic Data, Engine Off

NOTE: Hybrid Electric Vehicles (HEVs) have engine controls that can start and stop the engine without regard to ignition setting. The operator must ensure that the engine is off when performing the test.

Purpose: To verify that all OBD Compliant ECUs transmit appropriate diagnostic DM24 response to determine which SPNs are supported by each ECU and to check that the returned data is valid for engine-off conditions.

Procedure:

- Test Computer transmits SAE J1939 Request for DM24 (SPN support for Freeze Frame and Data Stream) to each OBD compliant ECU on the vehicle. The DM24 responses will use the SAE J1939 Transport Protocol. Note the SPNs reported by each ECU as being supported.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	0 (Engine), other OBD compliant ECUs	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	$B6_{16}$
Byte 2	(i.e., DM24 - PGN = 64950_{10}, $00FCB6_{16}$)	FD_{16}
Byte 3		00_{16}

FIGURE 10 - SPN SUPPORTED FOR FREEZE FRAME AND DATA STREAM (DM24) REQUEST MESSAGE

Message PGN:	64950 (DM24)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1-n	As defined for DM24 in SAE J1939-73. Note: n > 8 so Transport Protocol is used.	See DM24 definition

FIGURE 11 - ECU#X RESPONSE: SPN SUPPORTED (DM24) RESPONSE MESSAGE

Evaluation criteria:

- If no DM24 response is received from each OBD ECU, a failure shall be flagged.

- If a DM24 response is received from at least one ECU, then the test unit should verify that the SPNs 92, 110, 190, and 84 are reported at least once as Data Stream parameters among all the Data Steam parameter responses. If all four SPNs are not supported, a failure will be flagged.

- Monitor the SAE J1939 Data Link for the presence of these SPNs, noting that the appropriate values for 190 and 84 should be zero for the vehicle at rest and the engine off. If these two SPNs are not reported, or reported with non-zero value, a failure will be flagged.

- Note that a lack of support for DM24 is not necessarily a failure, depending on the level of OBD support that the ECUs have reported. DM24 (and DM25) are required for ECUs supporting the California CCR 1971.1 regulation, but not for previous regulations such as CCR 1968.1.

7.2   Verify Communication with Engine Running

Purpose: Verify that the allowed protocol is supported and that a response message of the correct format is sent by the vehicle with engine running.

Procedure:

- Move ignition to crank position and start engine. Let engine idle for 1 min.

NOTE: Some powertrain control systems have engine controls that can start and stop the engine without regard to ignition position or setting. The operator must ensure that the engine is running when performing the test, e.g., turn on A/C.

- Repeat the tests in 6.2 through 6.6, but with engine running. Note that the evaluation criteria for test 6.6.1 this time is SPN 84 (vehicle speed) should be zero and SPN 190 (engine speed) should not be zero.

7.2.1   Verify DM4 – Request Powertrain Freeze Frame Data, Engine Running

Purpose: To verify that all ECUs respond correctly to requests for DM4 when there is no DTC stored, that at least one ECU supports Freeze Frames, and that the current Freeze Frame is empty (since faults have been cleared.)

Procedure:

- Test Computer transmits SAE J1939 request message for DM4 to determine which ECUs support Freeze Frames.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CD_{16}
Byte 2	(i.e., DM4 - PGN = 65229_{10}, $00FECD_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 12 - FREEZE FRAME (DM4) REQUEST MESSAGE

Message PGN:	65229 (DM4)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1-8	As defined for DM4 in SAE J1939-73 (should be Zero in byte 1 to indicate no faults)	See DM4 definition

FIGURE 13 - ECU#X RESPONSE: FREEZE FRAME (DM4) RESPONSE MESSAGE

Evaluation criteria:

- Verify at least one OBD compliant ECU must support Freeze Frames; else this shall be flagged as a failure. This support may be provided by DM4 or DM25, depending on the compliance level (if no ECU supports DM4, request DM25 to assure support.)

- Verify each ECU that returns a Freeze Frame (DM4) message must have bytes 1-5 of the data portion of the message set to zero, since faults have been cleared and there is thus no Freeze Frame data available.

7.3   Verify Vehicle Information, Engine Running

Purpose: To verify that all ECUs respond correctly to SAE J1939 requests with the engine running and to verify that VIN and DM19 (CAL IDs, and CVNs) are supported in the returned responses for reprogrammable ECUs.

Procedure:

- Test Computer sends SAE J1939 request message for VIN PGN to the Global Address. Test Computer sends DM19 to each OBD compliant ECU to get CAL ID and CVN.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	EC_{16}
Byte 2	(i.e., Vehicle ID - PGN = 65260_{10}, $00FEEC_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 14 - VIN REQUEST MESSAGE

Message PGN:	65260 (Vehicle Identification)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1-n	As defined for Vehicle Identification in SAE J1939-71 (Data will be the ASCII values for the characters that make up the VIN: 17 letters and numbers)	See definition in SAE J1939-71, VIN assigned by Mfgr.

FIGURE 15 - ECU#X RESPONSE: VIN MESSAGE

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	0 (Engine), other OBD compliant ECUs	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	00_{16}
Byte 2	(i.e., DM19 - PGN = 54016_{10}, $00D300_{16}$)	$D3_{16}$
Byte 3		00_{16}

FIGURE 16 - CALIBRATION INFORMATION (DM19) REQUEST MESSAGE

Message PGN:	54016 (DM19)	
Source Addr:	SA of Responding ECU	
Destination Addr:	SA of Test Computer	
Data:	Data Description	Byte Value (Hex)
Byte 1-8	As defined for DM19 in SAE J1939-73 (CVN, CAL ID pairs)	See DM19 definition

FIGURE 17 - ECU#X RESPONSE: CALIBRATION INFORMATION (DM19) RESPONSE MESSAGE

Evaluation criteria:

- Verify that all ECUs respond correctly to SAE J1939 requests.

- If more than one VIN is reported for the vehicle, a failure will be flagged. If multiple ECUs report VIN, all must be identical.

- The VIN year character (position 10) must correspond to the model year entered by the operator in the Test Computer and must be in accordance with the appropriate specification for the format of the VIN.

| VIN Character | SAE J272 | ISO 3779 |

FIGURE 18 - VIN REFERENCE

- All CAL IDs must contain 1 to 16 printable ASCII characters.

- Test Computer operator prompt asks for the number of emission-related ECUs in the vehicle. Verify that CAL IDs and CVNs are supported by the expected number of ECUs, and agree with the expected response.

- Test Computer operator prompt asks for the number of emission-related ECUs in the vehicle. Each emission-related ECU shall output one or more CAL IDs (every OBD ECU must report its own CAL ID; however, some ECUs may report multiple CAL IDs). If CAL IDs do not match expected value, then flag as a warning.

7.4   Test vehicle with a fault code by inducing a fault

Purpose: This group of tests will establish that under normal operating conditions communication can be established and that all supported test services behave correctly in the presence of an induced fault.

7.4.1   Induce Circuit Fault

Purpose: Induce a circuit fault that will generate a MIL light and a single DTC with the engine idling in preparation for the services tests in the remainder of the tests in this section.

Procedure:

- With ignition off and engine off, disconnect a sensor that is tested underlined continuously (e.g., Engine coolant temperature, Intake Manifold Pressure, Atmospheric Pressure, Fuel Pressure, etc.).

Fault selection criteria:

- The selected fault should generate a MIL light and a single DTC with the engine idling in a short period of time (i.e., < 10 s) for only one ECU.

- The selected fault shall illuminate the MIL during the first driving cycle to allow proper testing in a manufacturing setting. In this case, a pending DTC a confirmed DTC and MIL will be set on the first driving cycle.

NOTE: This will not completely test the functions of the Pending DTC or Freeze Frame capture for Pending DTCs, but this is not needed to test the communication capabilities of the system.

Start engine, let idle for 1 min or whatever time it takes to set a pending DTC. Note: Some powertrain control systems have engine controls that can start and stop the engine without regard to ignition position. The operator must ensure that the engine is on when performing the test, e.g., turn on A/C or defroster.

7.4.2   Establish Communication (SAE J1939), Engine Running

Purpose: To verify that the SAE J1939 protocol is supported and that the response message of the correct format is sent by the vehicle.

Procedure:

- Test Computer sends SAE J1939 request message for the DM5 (Diagnostic Readiness 1) message to the Global Destination address.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CE_{16}
Byte 2	(i.e., DM5 - PGN = 65230_{10}, $00FECE_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 19 - DIAGNOSTIC READINESS 1 (DM5) REQUEST MESSAGE

Message PGN:	65230 (DM5)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1-8	As defined for DM5 in SAE J1939-73	See DM5 definition

FIGURE 20 - ECU#X RESPONSE: DIAGNOSTIC READINESS 1 (DM5) RESPONSE MESSAGE

Evaluation criteria:

If the specified number of emissions-related modules do not positively respond to an OBD diagnostic message, this shall be flagged as a failure.

7.4.3   Verify DM6 – Request Pending Emission-Related DTCs, Engine Running

Purpose: To verify that all modules respond correctly to a DM6 (Pending DTCs) request and there is at least one pending emission-related DTC reported.

Procedure:

- Every 0.500 s, Test Computer will send a SAE J1939 Request message for DM6 to Global Address to get pending DTCs. If DTC is set, Test Computer will prompt user that DTC has been set and to continue. If no pending DTC is set, after 30 s the Test Computer will prompt the user to continue without a pending DTC (logged as a failure).

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CF_{16}
Byte 2	(i.e., DM6 - PGN = 65231_{10}, $00FECF_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 21 - PENDING EMISSION RELATED DTCS (DM6) REQUEST MESSAGE

Message PGN:	65231 (DM6)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1	Lamp Status (See DM6 for specifics)	XX
Byte 2	Lamp Status (See DM6 for specifics)	XX
Byte 3	1st Pending DTC=[SPN Low 8 bits,	XX
Byte 4	SPN Mid 8 bits,	XX
Byte 5	SPN Upper 3 bits and FMI,	XX
Byte 6	SPN Method and Occurrence Cnt]	XX
:	:	:
Byte n*4–1	nth Pending DTC=[SPN Low 8 bits,	XX
Byte n*4	SPN Mid 8 bits,	XX
Byte n*4+1	SPN Upper 3 bits and FMI,	XX
Byte n*4+2	SPN Method and Occurrence Cnt]	XX

FIGURE 22 - ECU#X RESPONSE: PENDING EMISSION RELATED DTCS (DM6) RESPONSE MESSAGE

Evaluation criteria:

Verify at least one DM6 pending DTC response with a non-zero DTC should be received. If at least one is not received it shall be flagged as a failure.

7.5   Verify DM25 – Request Expanded Freeze Frame (DM25) Data

Purpose: To verify that all modules respond correctly to DM25 (Expanded Freeze Frame) requests if a freeze frame is stored and expanded freeze frame support is required by the regulations.

Procedure:

- The Test Computer will send a SAE J1939 Request message for DM25 to the Global destination address to read freeze frame data (DTC).

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	$B7_{16}$
Byte 2	(i.e., DM25 - PGN = 64951_{10}, $00FDB7_{16}$)	FD_{16}
Byte 3		00_{16}

FIGURE 23 - FREEZE FRAME DATA (DM25) REQUEST MESSAGE

Message PGN:	64951 (DM25)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1	1st Freeze Frame Length	XX
Byte 2	1st FF DTC = [SPN Low 8 bits,	XX
Byte 3	SPN Mid 8 bits,	XX
Byte 4	SPN Upper 3 bits and FMI,	XX
Byte 5	SPN Method and Occurrence Cnt]	XX
Byte 6	Parameter Data for 1st Freeze Frame	XX
:		:
Byte m		XX
:	:	:
Byte (n-1)*m + 1	nth Freeze Frame Length	XX
Byte (n-1)*m + 2	nth FF DTC = [SPN Low 8 bits,	XX
Byte (n-1)*m + 3	SPN Mid 8 bits,	XX
Byte (n-1)*m + 4	SPN Upper 3 bits and FMI,	XX
Byte (n-1)*m + 5	SPN Method and Occurrence Cnt]	XX
Byte (n-1)*m + 6	Parameter Data for nth Freeze Frame	XX
:		:
Byte m*n		XX

FIGURE 24 - ECU#X RESPONSE: FREEZE FRAME (DM25) RESPONSE MESSAGE

Evaluation criteria:

- If at least one ECU complying with OBD level of CCR1971.1 does not support DM25, this shall be flagged as a failure.

- For each ECM that supports DM25, verify the Freeze Frame length(s) correctly correspond with the length of the Data field. If the Freeze Frame length and Data field length do not correspond correctly, then this shall be flagged as a failure.

7.6   Verify DM4 – Request Freeze Frame Data, Engine Running

Purpose: To verify that all modules respond correctly to DM4 (Freeze Frame) requests if a freeze frame is stored.

7.6.1   Standard Freeze Frame

Procedure:

- The Test Computer will send a SAE J1939 Request message for DM4 to the devices that responded to DM5 as an OBD compliant device.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	0 (Engine), other OBD compliant ECUs	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CD_{16}
Byte 2	(i.e., DM4 - PGN = 65229_{10}, $00FECD_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 25 - FREEZE FRAME DATA (DM4) REQUEST MESSAGE

Message PGN:	65229 (DM4)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1	1st Freeze Frame Length	XX
Byte 2	1st FF DTC = [SPN Low 8 bits,	XX
Byte 3	SPN Mid 8 bits,	XX
Byte 4	SPN Upper 3 bits and FMI,	XX
Byte 5	SPN Method and Occurrence Cnt]	XX
Byte 6	1st FF Required Parameters Data	XX
:		:
Byte 13		XX
Byte 14	1st FF Optional Parameters Data	XX
:		:
Byte m		XX
:	:	:
Byte k + 1	nth Freeze Frame Length [starts at k = m * (n − 1) + 1]	XX
Byte k + 2	nth FF DTC = [SPN Low 8 bits,	XX
Byte k + 3	SPN Mid 8 bits,	XX
Byte k + 4	SPN Upper 3 bits and FMI,	XX
Byte k + 5	SPN Method and Occurrence Cnt]	XX
Byte k + 6	nth FF Required Parameters Data	XX
:		:
Byte k + 13		XX
Byte k + 14	nth FF Optional Parameters Data	XX
:		:
Byte k + m		XX

FIGURE 26 - ECU#X RESPONSE: FREEZE FRAME (DM4) RESPONSE MESSAGE

Evaluation criteria:

- If an ECU does not support DM4, it shall respond with a NACK to a DM4 request instead of the Figure 26 data bytes.

- If an ECU supports DM4 but has no accumulated freeze frames to report, it shall respond with a DM4 message with $00 in byte 1, $00 in bytes 2 through 5 and $FF in bytes 6 through 8

- Freeze frame may be stored when pending DTC is set, however, it is not required. If freeze frame is not stored for pending codes, byte 1 of the DM4 message is reported as $00 for each ECU response. If this is the case, skip the remainder of 7.6.

- if freeze frame is supported for pending codes, verify that a Freeze Frame DTC in the DM4 messages is the same as one of the DTCs reported in DM6 for the ECU.

7.6.2   Pending Fault Freeze Frame

If freeze frame is supported for pending codes (i.e., an ECU responded with a Freeze Frame DTC in DM4) then verify there is data for the required parameters (bytes 6 through 13) for each freeze frame.

Procedure:

- The Test Computer will send a SAE J1939 Request message for DM4 to the devices that responded to DM5 as an OBD compliant device

Evaluation criteria:

- If at least one ECU does not support DM4 or DM25 (see 7.4), this shall be flagged as a failure.

- If only one ECU supports DM4, at a minimum, byte 6 through byte 13 must be supported by applicable OBD ECU.

- If an ECU that responded with a freeze frame in DM4 and the freeze frame data indicates "Not Available" for one or more of the SPNs in bytes 6 to 13, this shall be flagged as a failure.

7.7   Verify DM24 – Request SPN Support (DM24)

Purpose: To verify that all modules respond correctly to DM24 (SPN Support) requests with one or more SPNs with 'Expanded Freeze Frame Support' indicated if expanded freeze frame support is required by the regulations.

Procedure:

If expanded freeze frame (DM25) is supported, then send a DM24 (Supported SPNs) request to the Global Destination address to determine the list of SPNs for the freeze frame data.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	$B6_{16}$
Byte 2	(i.e., DM24 - PGN = 64950_{10}, $00FDB6_{16}$)	FD_{16}
Byte 3		00_{16}

FIGURE 27 - SPN SUPPORT (DM24) REQUEST MESSAGE

Message PGN:	64950 (DM24)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1	1st SPN Supported = [SPN Low 8 bits,	XX
Byte 2	SPN Mid 8 bits,	XX
Byte 3	SPN Upper 3 bits & Support Type]	XX
Byte 4	SPN Data Length (1st SPN)	XX
:		:
Byte (n*4)-3	nth SPN Supported = [SPN Low 8 bits,	XX
Byte (n*4)-2	SPN Mid 8 bits,	XX
Byte (n*4)-1	SPN Upper 3 bits & Support Type]	XX
Byte (n*4)	SPN Data Length (nth SPN)	XX

FIGURE 28 - ECU#X RESPONSE: SPN SUPPORT (DM24) RESPONSE MESSAGE

Evaluation criteria:

- If at least one ECU that supports OBD at the California CCR 1971.1 level does not support DM24, this shall be flagged as a failure.

- For each ECU that supports DM24, verify the SPN for each of the minimum required freeze frame parameters is reported with the Expanded Freeze Frame support indicated in the SPN Support Type.

- If the DM24 response (SPN Support) for an ECU that responded to DM25 indicates that no SPNs are supported for freeze frame, this shall be flagged as a failure.

7.8   Verify DM12 – Request Emission-Related DTCs, Engine Running

Purpose: To verify that a proper response indicating a stored DTC is received and to verify that the MIL is on.

Procedure:

- The Test Computer will send a SAE J1939 Request message for DM12 to the Global Destination address. Verify that a proper response is received.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	$D4_{16}$
Byte 2	(i.e., DM12 - PGN = 65236_{10}, $00FED4_{16}$)	FE_{16}
Byte 3		00_{16}

FIGURE 29 - EMISSION RELATED DIAGNOSTIC TROUBLE CODE (DM12) REQUEST MESSAGE

Message PGN:	65236 (DM12)	
Source Addr:	SA of Responding ECU	
Destination Addr:	N/A (PGN does not support Destination Addressing)	
Data:	Data Description	Byte Value (Hex)
Byte 1	Lamp Status (See DM12 for specifics)	XX
Byte 2	Lamp Status (See DM12 for specifics)	XX
Byte 3	1st emissions DTC=[SPN Low 8 bits,	XX
Byte 4	SPN Mid 8 bits,	XX
Byte 5	SPN Upper 3 bits and FMI,	XX
Byte 6	SPN Method and Occurrence Cnt]	XX
:	:	:
Byte n*4–1	nth emissions DTC=[SPN Low 8 bits,	XX
Byte n*4	SPN Mid 8 bits,	XX
Byte n*4+1	SPN Upper 3 bits and FMI,	XX
Byte n*4+2	SPN Method and Occurrence Cnt]	XX

FIGURE 30 - ECU#X RESPONSE: EMISSION RELATED DTCS (DM12) RESPONSE MESSAGE

Evaluation criteria:

- If an ECU does not support DM12, it shall not respond to a DM12 request sent to the Global Destination address.

- If an ECU supports DM12 but has no confirmed DTC and is not requesting the MIL on, it shall respond with a DM12 message with 00_2 or 11_2 for MIL status (byte 1, bits 8-7), $00 in bytes 3 through 6, and $FF in bytes 7 through 8.

- At least one ECU should transmit DM12 with data indicating the fault that was created in 7.1 if the chosen fault was one that completes in a single drive cycle.

8. NOTES

8.1   Application Notes

It is assumed that these tests will also be conducted during component or vehicle development. If the tests are to be run off vehicle, out of order, or the initial conditions have not been controlled, then care needs to be taken when interpreting the results.

8.2   Marginal Indicia

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

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