



SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1939-84 JUN2012

Issued 2008-12
Revised 2012-06

Superseding J1939-84 DEC2010

(R) OBD Communications Compliance Test Cases for Heavy Duty Components and Vehicles

RATIONALE

This version provides for the observation of the MIL_On to MIL_Off transition for a single trip CCM fault and reformats tables in section 6 to improve ease of use.

FOREWORD

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. The SAE J1939-84 document describes the tests and procedures to verify the SAE J1939 diagnostic message communication from an off board diagnostic tool (i.e. scan tool) to a vehicle and/or component fulfill certain on-board diagnostic (OBD) regulatory requirements heavy duty engines used in medium and heavy duty vehicles. The SAE J1939 communications network is a high speed ISO 11898-1 CAN based communications network that supports real-time closed loop control functions, simple information exchanges, and diagnostic data exchanges between Electronic Control Units (ECUs) physically distributed throughout the vehicle.

The SAE J1939 communications network is developed for use in heavy-duty environments and suitable for horizontally integrated vehicle industries. The SAE J1939 communications network is applicable 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.

The physical layer aspects of SAE J1939 reflect its design goal for use in heavy-duty environments. Horizontally integrated vehicles involve the integration of different combinations of loose package components, such as engines 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.

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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.

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. The December 2010 version of the document added 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 user should reference the summary provided by SAE J1939-73 Table 1 and Table 2 for OBD compliance support.

2. REFERENCES

At the time of publication there are no known conflicts between this specifications, cited regulations, and the normative references in section 2.1.1 for 2013 HD OBD regulations. Cited regulations take precedence over this specification and references in section 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 specified, 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	Serial Control and Communications Heavy Duty Vehicle Network – Top Level Document
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 May 2010)
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 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 where used.

3.1 Definition of Terms

Drive Cycle – An engine or vehicle operating profile as described by OBD regulations including 13 CCR 1971.1.

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 Section 2.1, Applicable Publications.

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 provide data that adheres to the data structure defined in the SAE J1939-73, J1939-71 and other referenced documents, and can be interpreted using those 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 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 J1939 communications. The test computer and the vehicle's 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 J1939 Interfaces for diagnostic communications, use of an RP1210B API for PVE testing is highly desirable.

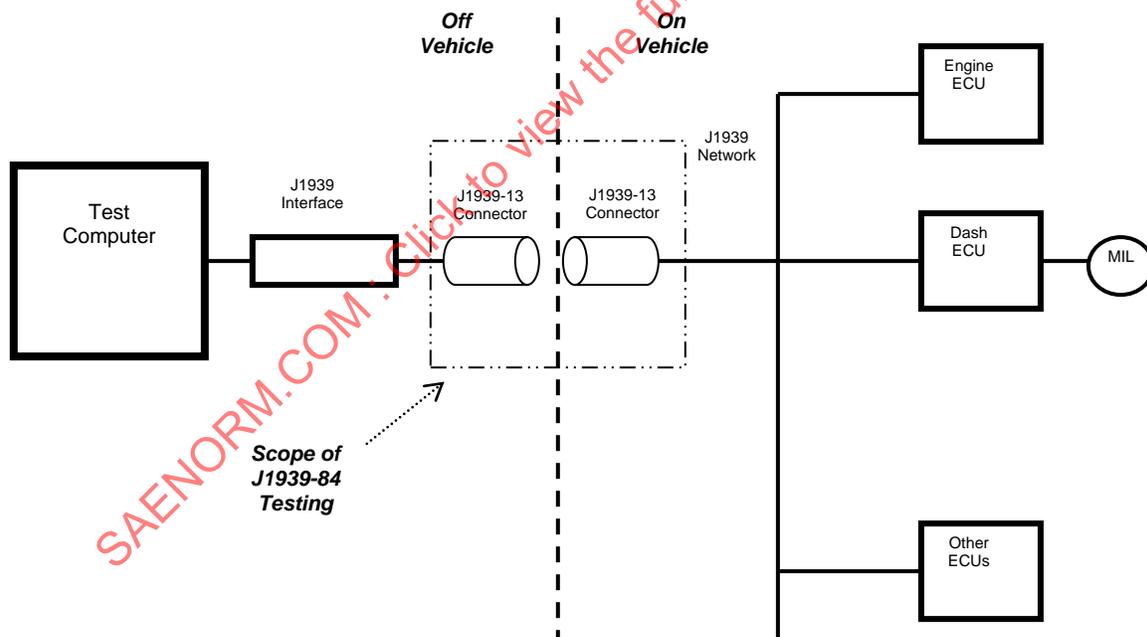


FIGURE 1 – SAE J1939-84 TEST SCOPE OVERVIEW

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 [13 CCR 1971.1 (I)(1) Verification of Standardized Requirements]. 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 (I)(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. Some incomplete vehicles may detect failures for equipment that is to be installed during a later stage of vehicle manufacture for the vehicle application's equipment and equipment operating controls.

5.2 Test Conditions

Tests shall be performed using a stationary vehicle under ambient temperatures between 10 and 35 degrees Celsius. If the battery voltage falls below 12 volts (or 24 volts for a 24-volt 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 J1939-13 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 demonstrate MIL_Status – Test procedures assume that the method will induce a single trip continuous component monitoring fault, using sensors which are most likely to be readily accessible for the test technician to disconnect, and that such faults will be detected as failures within an efficient time frame. The recommended method shall support drive cycle counting without vehicle movement. The failure maturation time and operating profile needed to detect the fault produced by the recommendation and recognize its drive cycle shall be documented for the test. See section 6.8.
- 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?
- SPN and FMI recommended to demonstrate completed test results – The recommendation may define an SPN and FMI that does not support the idle control or misfire monitors or demonstrates MIL_Status as a single trip fault.
- 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?
- Waiting Time – The amount of time a technician should wait in between test steps or for a fault to mature.

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 J1939-73 Diagnostic Messages and 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 J1939-13 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 msec. 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 msec. 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 (R)

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 sections 6.1 through 6.9. Section 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

Test Section	Test Section Objectives	Test 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 the 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 seconds. [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

Test Section	Test Section Objectives	Test Section Summary
		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. MIL_Status shall transition from On to Off after three drive cycles for the fault have been concluded.
IX	Engine Off – Verify Engine Running Fault Clears	Verify fault can be cleared after engine off
	Turn engine off and wait before starting step 1 of section IX. The wait time (as defined by the manufacturer in section 5.3) 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 section 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) emissions related 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	Test Step Objective	Stimulus	Response	Criteria
§I	Vehicle Qualification – Key On Engine Off – No Faults		Verify Initial Conditions.	
1	Verify MIL_Status = Off during the bulb check period.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	MIL_Status shall be reported as off in SPN 1213.
2	Request Addresses and Names in use by network.	Address Claim (See Figure A.6. J1939-81).	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.
3	Claim Tool Address	Claim Address 250 or 249 (See Figure A.6. J1939-81).	Claim an off-board tool address.	Fail if tool cannot claim either address.
4	Verify OBD_Compliance defines the engine as an HD OBD Engine.	Diagnostic Readiness 1 (DM5) Request Message [G]	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. [2013 MY allowed values are 19 or 20.]
5	Verify that CAL ID matches the test request.	Calibration Information (DM19) Request Message [G]	ECU#X Response: Calibration Information (DM19) Response Message	CAL ID and CVN shall match test request.
6	Verify Vehicle VIN.	VIN Request Message [G]	ECU#X Response: VIN (VI) Message (PGN 65260)	VIN provided shall match door jam plate and test request
7	Clear faults prior to subsequent test steps.	Clear Active Diagnostic Codes (DM11) Request Message [D]	ECU#X Response: Acknowledge Message	Requests to clear faults shall be accepted for engine off conditions.
8	Verify Engine Serial Number	Component Identification (CI) [D]	ECU#X Response: Component Id (CI) Message (PGN 65259)	Verify that the 3 rd field of the CI response provides a non-zero engine serial number
9	Verify there are no active emissions-related faults.	Active Emissions- Related Faults (DM12) Request Message [G]	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	Verify SPN 0, FMI 0, OC 0 and CM = 0 response defined in J1939-73 paragraph 5.7.12. [Stop testing and repair vehicle if any faults are observed.]
10	Verify there are no pending faults	Pending Emissions- Related Faults (DM6) Request Message [G]	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	Verify SPN 0, FMI 0, OC 0 and CM = 0 response defined in J1939-73 paragraph 5.7.6 [Stop testing and repair vehicle if any faults are observed.]
11	Verify there are no previously active emissions related faults.	Previously Active Emissions Related DTCs (DM23) Request Message [G]	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	Verify SPN 0, FMI 0, OC 0 and CM = 0 response defined in J1939-73 paragraph 5.1.23 [Stop testing and repair vehicle if any faults are observed].
12	Verify there are no permanent faults.	Permanent DTCs (DM28) Request Message [G]	ECU#X Response: Permanent DTCs (DM28) Response Message	Note any permanent faults received in the test log.
13	Verify there are no active faults.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	There must be no emissions related faults. [Non-emissions related faults may be tolerated owing to incomplete vehicle construction effects.]
14	Verify HD OBD fault counts in SPNs 4104 through 4108	DTC Counts (DM29) Request Message [G]	ECU#X Response: DTC Counts (DM29) Response Message	Verify DTC counts match prior display messages. [All are expected to be zero.] [Record counts in test log.]
15	Verify Active and Previously active counts in DM5 are zero.	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify Active and Previously active counts in DM5 are zero in SPNs 1218 and 1219.

§I Step	Test Step Objective	Stimulus	Response	Criteria
16	Verify readiness	Use prior response	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify supported monitors are not ready in SPNs 1221, 1222, and 1223. [CCM may be reported as ready].
17	Request supported Freeze Frame and broadcast data.	SPN Supported For Freeze Frame And Data Stream (DM24) Request Message [D]	ECU#X Response: SPN Supported (DM24) Response Message	[Record SPN support in test log.]
18	Verify that the freeze frame is empty.	Expanded Freeze Frame (DM25) Request Message [D]	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	Verify format matches DM24 display. [An empty freeze frame should be conveyed.]
19	Confirm availability of supported broadcast data.	N/A	ECU#X Supported Broadcast Data Confirmation	Identify each broadcast SPN from those identified in DM24.
20	Confirm on request data is available.	On Request PGN Request Message for each PGN not observed in step 19 [D]	ECU#X Response: On Request PGN	Fail test if any SPN is not supported. [Note some SPNs may only be supported as test results].
21	Verify distances and times are zero.	Diagnostic Readiness 2 (DM21) Request Message [G]	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	SPNs 3069, 3294, 3295, and 3296 should display zeros after DM11 in step 8.
22	Verify supported trip monitors are not ready.	Diagnostic Readiness for This Trip (DM26) Request Message [G]	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	Verify readiness is set to not ready in SPNs 3303, 3304 and 3305. [CCM may be reported as ready].
23	Verify test results are not available for all tests for the selected SPN.	Command Non-Continuously Monitored Test (DM7) Request Message (TID = 247) [D]	ECU#X Response: Scaled Test Results (DM30)	Select an SPN having test data support from the DM24 display and query for test results using the selected SPN. [See J1939-73 Table 6 row 3.]
24	Verify individual test result support.	Command Non-Continuously Monitored Test (DM7) Request Message (TID = 250) [D]	ECU#X Response: Scaled Test Results (DM30)	Select an SPN and FMI from those displayed in the previous response or that recommended by the manufacturer.
25	Verify performance monitor ratio support.	Monitor Performance Ratio (DM20) Request Message [G]	ECU#X Response: Monitor Performance Ratio (DM20)	Verify response data is properly formatted. [See J1939-73 Table 18].
26	Verify EI-AECD support.	Emission Increasing- AECD Active Time (DM33) Request Message [D]	ECU#X Response: Emission Increasing- AECD Active Time (DM33)	Verify response data is properly formatted. [Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
27	Verify NTE Status support.	NTE Status (DM34) Request Message [G]	ECU#X Response: NTE Status (DM34) Message	Verify properly formatted response provided.
	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 minutes. 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	Test Step Objective	Stimulus	Response	Criteria
§II	Key On Engine Off – CCM Failure Stimulation		Verify Engine Off System Response to Fault.	
		[NOTE: Implant fault].		[Then, monitor for failure to mature].
1	Verify MIL_Status = On in SPN 1213.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Fail if MIL_Status remains Off. [Allow at least 5 minutes (or a shorter the time recommended by the manufacturer) for the fault to mature.]
2	Collect SA for destination specific requests.	Diagnostic Readiness 1 (DM5) Request Message [G]	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	Iterate multiple responses for subsequent destination specific requests
3	Retrieve the confirmed fault indicated by MIL_Status = On.	Active Emissions- Related Faults (DM12) Request Message [D]	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. Verify DTC is provided according to J1939-73 paragraph 5.7.12.
4	Verify there are no (or one) pending faults.	Pending Emissions- Related Faults (DM6) Request Message [D]	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, OC 0 and CM 0. Some Federal HD OBD systems may retain their pending fault for subsequent deletion. 13 CCR 1971.1 (d)(2.2.2)(B) requires deletion of pending faults in 10 seconds.]
5	Verify there are no previously active faults.	Previously Active Emissions Related DTCs (DM23) Request Message [D]	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.]
6	Verify that a permanent fault is set.	Permanent DTCs (DM28) Request Message [D]	ECU#X Response: Permanent DTCs (DM28) Response Message	The confirmed fault shall also be displayed as a permanent fault, (when set for CCM faults).
7	Verify Active fault.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Verify Active fault provided matches DM12 results. Verify DTC is provided according to J1939-73 paragraph 5.7.12.
8	Verify DTC counts in SPNs 4104 through 4108.	DTC Counts (DM29) Request Message [D]	ECU#X Response: DTC Counts (DM29) Response Message	[Typically, one or zero DTCs]

§II Step	Test Step Objective	Stimulus	Response	Criteria
9	Verify the Active and Previously Active Counts.	DTC Counts / Diagnostic Readiness (DM5) Request Message [D]	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	There should be 1 active fault and no previously active faults in SPNs 1218 and 1219.
10	Verify support with faults present.	SPN Supported For Freeze Frame And Data Stream (DM24) Request Message [D]	ECU#X Response: SPN Supported (DM24) Response Message	[This should provide the same response as test section I.]
11	Verify freeze frame (if provided for CCM fault).	Expanded Freeze Frame (DM25) Request Message [D]	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	The freeze frame shall display the sole CCM fault. Verify format matches DM24 display.
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	Test Step Objective	Stimulus	Response	Criteria
§III	Key On Engine Off – Clear CCM Failure		Verify Clear Fault System Response. [Responses should remain, as fault still exists.]	
1	Clear Active Fault	Clear Active Diagnostic Codes (DM11) Request Message [D]	ECU#X Response: Acknowledge Message	Implementation dependent, an ECU may NACK the 'uncleared' fault, as a failed operation.
2	Verify MIL_Status = On in SPN 1213.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status = On. [MIL may remain off for a brief period of time, when the positive acknowledge was provided.]
3	Verify Fault Count	Diagnostic Readiness 1 (DM5) Request Message [D]	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	Verify the active fault count in SPN 1218. Verify there are no previously active faults in SPN 1219.
4	Verify the confirmed fault is retained.	Active Emissions - Related Faults (DM12) Request Message [G]	ECU#X Response: Active Emissions-Related Faults (DM12) Response Message	The same fault shown in Section II shall be displayed. Verify DTC is provided according to J1939-73 paragraph 5.7.12.
5	Verify there are no (or one) pending faults.	Pending Emissions- Related Faults (DM6) Request Message [G]	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 seconds. Federal regulations allow more time.]
6	Verify there are no previously	Previously Active Emissions Related	ECU#X Response: Previously Active	Verify SPN 0, FMI 0, OC 0 and CM = 0

§III Step	Test Step Objective	Stimulus	Response	Criteria
	active emissions related faults.	DTCs (DM23) Request Message [G]	Emissions Related DTCs (DM23) Response Message	response defined in J1939-73 paragraph 5.7.23.
7	Verify Permanent faults.	Permanent DTCs (DM28) Request Message [G]	ECU#X Response: Permanent DTCs (DM28) Response Message	Verify a permanent fault is set (if set for CCM faults).
8	Verify DTC counts.	DTC Counts (DM29) Request Message [G]	ECU#X Response: DTC Counts (DM29) Response Message	[Typically, one or zero DTCs in SPNs 4104 4105, 4106, 4107 and 4108].
9	Verify active and previously active counts.	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	SPNs 1218 and 1219 should display zero in DM5.
10	Verify times and distances in SPNs 3069, 3294, 3295, and 3296.	Diagnostic Readiness 2 (DM21) Request Message [G]	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.]
11	Verify trip monitor support with faults present.	Diagnostic Readiness for This Trip (DM26) Request Message [G]	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	Verify readiness is set to not ready in SPNs 3303, 3304 and 3305. [CCM may be reported as ready]. [This should result in the same response as Section II.]
12	Verify freeze frame (if provided for CCM fault).	Expanded Freeze Frame (DM25) Request Message [D]	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	Verify format matches DM24 display. [This should result in same response as Section II.]
	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.			

6.4 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	Test Step Objective	Stimulus	Response	Criteria
§IV	Key On Engine Off – Correct CCM Failure		Verify Behavior with Fault Removed	
1	Verify MIL_Status = On.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status = On. [MIL should be latched for 3 cycles in SPN 1213.]
2	Verify DM12 retains fault	Active Emissions- Related Faults (DM12) Request Message [D]	ECU#X Response: Active Emissions-Related Faults (DM12) Response Message	Verify DM12 retains fault. Verify DTC is provided according to J1939-73 with CM = 0. paragraph 5.7.12.
3	Verify there are no (or one) pending faults. [No pending faults per 13 CCR 1971.1 (d)(2.2.2)(B)]	Pending Emissions- Related Faults (DM6) Request Message [D]	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 13 CCR 1971.1 (d)(2.2.2)(B).]
4	Verify there are no previously active faults.	Previously Active Emissions Related DTCs (DM23) Request Message [D]	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	Verify SPN 0, FMI 0, OC 0, and CM = 0 response defined in J1939-73 paragraph 5.7.23.
5	Verify the permanent fault set (if set for CCM faults).	Permanent DTCs (DM28) Request Message [D]	ECU#X Response: Permanent DTCs (DM28) Response Message	The DTC given by DM28 shall match the DTC given by DM12 in step 2.
6	Verify DTC counts match fault returns.	DTC Counts (DM29) Request Message [D]	ECU#X Response: DTC Counts (DM29) Response Message	Values displayed in SPNs 4104, 4105, 4106, 4107, and 4108 should match prior returns.
7	Verify active fault count	DTC Counts / Diagnostic Readiness (DM5) Request Message [D]	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify DTC counts match fault returns in SPN 1218.
8	Verify freeze frame, if provided for CCM fault.	Expanded Freeze Frame (DM25) Request Message [D]	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	The freeze frame shall display the sole CCM fault. Verify format matches DM24 display.
9	Verify times and distances in SPNs 3069, 3294, 3295, and 3296.	Diagnostic Readiness 2 (DM21) Request Message [D]	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.]
10	Verify Trip Readiness Response.	Diagnostic Readiness for This Trip (DM26) Request Message [D]	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	Verify readiness is set to not ready in SPNs 3303, 3304 and 3305. [This should result in the same response given in the Section III.]
11	Request Test Results	Command Non-Continuously Monitored Test (DM7) Request Message [D]	ECU#X Response: Scaled Test Results (DM30)	[There should still be no results for an ‘engine running’ test. See J1939-73 Table 6.]
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	Test Step Objective	Stimulus	Response	Criteria
§V	Key On Engine Off – Clear CCM Failure		Verify System Behavior with Fault Removed	
1	Fault should clear after having been repaired.	Clear Active Diagnostic Codes (DM11) Request Message [G]	N/A	No acknowledge message for global request
2	Verify there are no active emissions related faults.	Active Emissions- Related Faults (DM12) Request Message [G]	ECU#X Response: Active Emissions-Related Faults (DM12) Response Message	Verify SPN 0, FMI 0, and OC 0, and CM = 0 response defined in J1939-73 paragraph 5.7.12.
3	Verify there are no pending faults	Pending Emissions- Related Faults (DM6) Request Message [G]	ECU#X Response: Pending Emissions-Related Faults (DM6) Response Message	[There should be no pending faults after a clear request.]
4	Verify one (or no) permanent fault.	Permanent DTCs (DM28) Request Message [G]	ECU#X Response: Permanent DTCs (DM28) Response Message	[The permanent fault will be retained as no drive cycles have been completed.]
5	Verify there are no previously active faults.	Previously Active Emissions Related DTCs (DM23) Request Message [G]	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	Verify SPN 0, FMI 0, OC 0 and CM = 0 response defined in J1939-73 paragraph 5.7.23.
6	Verify there are no active faults.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Verify SPN 0, FMI 0, OC 0 and CM = 0 response defined in J1939-73 paragraph 5.7.1.
7	Verify fault counts are zero in SPNs 4104 through 4108.	DTC Counts (DM29) Request Message [G]	ECU#X Response: DTC Counts (DM29) Response Message	[Permanent fault count will equal 1 as no drive cycles have occurred.]
8	Verify fault counts are zero in SPNs 1218 and 1219.	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	The active fault count in SPN 1218 and the inactive fault count in SPN 1219 shall be zero.
9	Verify readiness	Use prior response	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify supported monitors are not ready in SPNs 1221, 1222, 1223. [CCM will be reported as ready].
10	Verify freeze frame data is empty.	Expanded Freeze Frame (DM25) Request Message [D]	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	Fail if a freeze frame is provided and DM6 confirms no pending faults.
11	Confirm availability of supported broadcast data.	N/A	ECU#X Supported Broadcast Data	Identify each broadcast SPN from those identified in DM24.
12	Confirm availability of on request data.	On Request PGN Request Message [D]	ECU#X Response: On Request PGN	Fail test if any SPN is not supported. [Note some SPNs may only be supported as test results].

§V Step	Test Step Objective	Stimulus	Response	Criteria
13	Verify times and distances are zero.	Diagnostic Readiness 2 (DM21) Request Message [G]	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	SPNs 3069, 3294, 3295, and 3296 should contain zeros.
14	Verify all trip monitors are not ready.	Diagnostic Readiness for This Trip (DM26) Request Message [G]	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	Verify readiness is set to not ready in SPNs 3303, 3304 and 3305. [CCM may be reported as ready].
15	Verify test results are not provided after fault is cleared.	Command Non-Continuously Monitored Test (DM7) Request Message [D]	ECU#X Response: Scaled Test Results (DM30)	See J1939-73 Table 6.
16	Verify Monitor Ratios	Monitor Performance Ratio (DM20) Request Message [D]	ECU#X Response: Monitor Performance Ratio (DM20)	Verify response data is properly formatted.
17	Verify EI-AECDs	Emission Increasing- AECD Active Time (DM33) Request Message [D]	ECU#X Response: Emission Increasing- AECD Active Time (DM33)	Verify response data is properly formatted. [Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
18	Verify NTE Status	NTE Status (DM34) Request Message [G]	ECU#X Response: NTE Status (DM34) Message	Verify response data is properly formatted.
19	Confirm on request data is available.	On Request PGN Request Message for each PGN not observed in step 18 [D]	ECU#X Response: On Request PGN	Fail test if any SPN is not supported. [Note some SPNs may only be supported as test results].
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	Test Step Objective	Stimulus	Response	Criteria
§VI	Engine Running – No Faults		Verify System Operation with Engine Running.	
1	Verify MIL_Status = Off, with engine running.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Fail if MIL_Status SPN 1213 turns on.
2	Verify OBD_Compliance defines the engine as an HD OBD engine.	Diagnostic Readiness 1 (DM5) Request Message [G]	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	[Allowed values for 2013 MY engines are 19 and 20.]
3	Verify fault counts are zero in SPNs 1218 and 1219.	Uses prior response.	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	[Note: non-emissions related faults that are displayed in DM1 will result in a count greater than zero.]
4	Verify CAL ID.	Calibration Information (DM19) Request Message [D]	ECU#X Response: Calibration Information (DM19) Response Message	The same result as given in section I shall be displayed.
5	Verify Vehicle VIN.	VIN Request Message [G]	ECU#X Response: VIN Message	[The same result as given in section I shall be displayed.]
6	Verify Engine Serial Number	Component Identification (CI) [D]	ECU#X Response: Component Id (CI) Message (PGN 65259)	Verify that the 3 rd field of the CI response provides the same engine serial number
7	Clear faults	Clear Active Diagnostic Codes (DM11) Request Message [D]	ECU#X Response: Acknowledge Message.	Engine may choose to NACK, when the engine is running
8	Verify there are no emissions active faults.	Active Emissions- Related Faults (DM12) Request Message [G]	ECU#X Response: Active Emissions-Related Faults (DM12) Response Message	No active emissions related faults shall be displayed.
9	Verify there are no pending faults.	Pending Emissions- Related Faults (DM6) Request Message [G]	ECU#X Response: Pending Emissions-Related Faults (DM6) Response Message	No pending faults shall be displayed. Verify SPN 0, FMI 0, OC 0 and CM = 0 response defined in J1939-73 paragraph 5.7.6.
10	Verify there are no previously active emissions related faults.	Previously Active Emissions Related DTCs (DM23) Request Message [G]	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	No previously active emissions related faults shall be displayed.
11	Verify there are no (or one) permanent faults.	Permanent DTCs (DM28) Request Message [G]	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.
12	Verify there are no active faults	N/A	ECU#X Active DTCs (DM1) Broadcast Message	
13	Verify DTC counts match prior display messages. (All are expected to be zero)	DTC Counts (DM29) Request Message [G]	ECU#X Response: DTC Counts (DM29) Response Message	[Record fault counts from SPNs 4104 through 4108 in the test log.]
14	Verify active and previously active fault counts in SPNs 1218 and 1219.	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify active and previously active counts in DM5 are zero.

§VI Step	Test Step Objective	Stimulus	Response	Criteria
15	Verify readiness	Use prior response	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify supported monitors are not ready in SPNs 1221, 1222, 1223. [CCM may be reported as ready].
16	Request supported SPNs for freeze frame and broadcast data.	SPN Supported For Freeze Frame And Data Stream (DM24) Request Message [D]	ECU#X Response: SPN Supported (DM24) Response Message	The same SPNs supported during section I shall be supported with the engine running.
17	Verify that the freeze frame is empty.	Expanded Freeze Frame (DM25) Request Message [D]	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	
18	Confirm availability of supported broadcast data.	N/A	ECU#X Supported Broadcast Data	Identify each broadcast SPN from those identified in DM24.
19	Confirm availability of on request data.	On Request PGN Request Message [D]	ECU#X Response: On Request PGN	
20	Verify distances and times are zero.	Diagnostic Readiness 2 (DM21) Request Message [G]	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	SPNs 3069, 3294, 3295, 3296 should contain zeros.
21	Verify supported trip monitors are not ready.	Diagnostic Readiness for This Trip (DM26) Request Message [G]	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	Verify readiness is set to not ready in SPNs 3303, 3304 and 3305. [CCM may be reported as ready.]
22	Verify test results are not available	Command Non-Continuously Monitored Test (DM7) Request Message [D]	ECU#X Response: Scaled Test Results (DM30)	See SAE J1939-73 Table 6.
23	Verify Monitor ratios	Monitor Performance Ratio (DM20) Request Message [G]	ECU#X Response: Monitor Performance Ratio (DM20)	Verify response data is properly formatted.
24	Verify EI AECDs	Emission Increasing- AECD Active Time (DM33) Request Message [D]	ECU#X Response: Emission Increasing AECD Active Time (DM33)	Verify response data is properly formatted. [Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
25	Verify NTE Status	NTE Status (DM34) Request Message [G]	ECU#X Response: NTE Status (DM34) Message	Verify response data is properly formatted
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	Test Step Objective	Stimulus	Response	Criteria
§VII	Engine Running – Response to Fault Stimulus		Verify System Operation with Failure Stimulus.	
1	Verify MIL_Status = On.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Fail if SPN 1213, MIL_Status, remains Off.
2	Collect SA for destination specific requests.	Diagnostic Readiness 1 (DM5) Request Message [G]	ECU#X Response: Diagnostic Readiness 1 (DM5) Response Message	Each identified device shall respond. Iterate multiple responses for subsequent destination specific requests.
3	Verify emissions active faults message.	Active Emissions- Related Faults (DM12) Request Message [D]	ECU#X Response: Active Emissions-Related Faults (DM12) Response Message	Verify DTC is provided according to J1939-73 paragraph 5.7.12.
4	Verify no (or one) pending faults are provided. [Per 13 CCR 1971.1 (d) pending faults are deleted in 20 seconds].	Pending Emissions- Related Faults (DM6) Request Message [D]	ECU#X Response: Pending Emissions-Related Faults (DM6) Response Message	[Note: Erasure of the pending fault when the fault has been confirmed will 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.]
5	Verify there are no previously active emissions related faults.	Previously Active Emissions Related DTCs (DM23) Request Message [D]	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	Verify SPN 0, FMI 0, and OC 0 and CM = 0 response defined in J1939-73 paragraph 5.7.23.
6	Verify there is one (or no) permanent fault(s).	Permanent DTCs (DM28) Request Message [D]	ECU#X Response: Permanent DTCs (DM28) Response Message	[The permanent fault from section II may be displayed.]
7	Verify active fault	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Verify there is one active fault in SPN 1218.
8	Verify DTC counts match prior display messages.	DTC Counts (DM29) Request Message [D]	ECU#X Response: DTC Counts (DM29) Response Message	All counts are expected to be one or zero in SPNs 4104 through 4108.
9	Verify active and previously active counts in DM5 are one or zero.	DTC Counts / Diagnostic Readiness (DM5) Request Message [D]	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	SPNs 1218 and 1219 should be displayed as one and zero.
10	Verify monitor support	Use prior response	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify supported monitors are not ready in SPNs 1221, 1222, and 1223. [CCM may be reported as ready.]
11	Request supported freeze frame and broadcast data.	SPN Supported For Freeze Frame And Data Stream (DM24) Request Message [D]	ECU#X Response: SPN Supported (DM24) Response Message	Verify a properly formatted DM24 response is received.
12	Verify that the freeze frame is empty for CCM fault.	Expanded Freeze Frame (DM25) Request Message [D]	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	Verify format matches DM24 display. [Note that the freeze frame may be empty for the CCM fault.]
13	Confirm availability of supported broadcast data.	N/A	ECU#X Supported Broadcast Data	Identify each broadcast SPN from those identified in DM24.

§VII Step	Test Step Objective	Stimulus	Response	Criteria
14	Confirm on request data is available as given in DM24 response.	On Request PGN Request Message(s) [D]	ECU#X Response: On Request PGN	Fail test if any SPN is not supported. [Note some SPNs may only be supported as test results].
15	Verify times are accumulating (non-zero) in SPNs 3295 and 3296.	Diagnostic Readiness 2 (DM21) Request Message [D]	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.]
16	Verify supported trip monitors are not ready.	Diagnostic Readiness for This Trip (DM26) Request Message [D]	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	Verify readiness is set to not ready in SPNs 3303, 3304 and 3305. [Misfire and CCM may be reported as ready.]
17	Verify test results for Cylinder 1 misfire.	Command Non-Continuously Monitored Test (DM7) Request Message [D]	ECU#X Response: Scaled Test Results (DM30)	[An alternate test may be recommended by the engine manufacturer.]
18	Verify Performance Ratio	Monitor Performance Ratio (DM20) Request Message [D]	ECU#X Response: Monitor Performance Ratio (DM20)	Verify response data is properly formatted.
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. MIL_Status shall transition from On to Off after three drive cycles for the fault have been concluded. This section is iterated a total of three times to obtain the transition observation. This observation shall not require the vehicle to move, but may require the engine to run.

TABLE 9 – ENGINE RUNNING CORRECT CCM FAILURE TEST PROCEDURE

§VIII Step	Test Step Objective	Stimulus	Response	Criteria
§VIII	Engine Running – Correct CCM Failure		Verify System Response with Failure Removed.	
1	Verify MIL_Status stays ON.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	If the maturation time is short, MIL_Status may appear as off on the third iteration. MIL status must be ON the first two iterations.
2	Verify Fault Remains in DM12.	Active Emissions- Related Faults (DM12) Request Message [G]	ECU#X Response: Active Emissions- Related Faults (DM12) Response Message	If the detection time is short, DM12 may display no faults on the third iteration. It is more important that DM12 match the DM1 display of MIL_Status, but a race condition could cause the third iteration to disagree.
3	Verify there are no pending faults.	Pending Emissions- Related Faults (DM6) Request Message [G]	ECU#X Response: Pending Emissions- Related Faults (DM6) Response Message	As the condition has been corrected there must be no pending fault.
4	Verify there is one (or no) permanent fault(s).	Permanent DTCs (DM28) Request Message [G]	ECU#X Response: Permanent DTCs (DM28) Response Message	Verify DTC is provided according to J1939-73 paragraph 5.7.28
5	Verify there are no previously active emissions related faults.	Previously Active Emissions Related DTCs (DM23) Request Message [G]	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	Verify SPN 0, FMI 0, OC 0, and CM = 0 response defined in J1939-73 paragraph 5.7.23.
6	Verify fault no longer appears in DM1.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	As the condition has been corrected there must be no active fault. Verify SPN 0, FMI 0, OC 0 and CM = 0 response defined in J1939-73 paragraph 5.7.1.
7	Verify DTC counts match fault receipts.	DTC Counts (DM29) Request Message [G]	ECU#X Response: DTC Counts (DM29) Response Message	Prior receipts should match data in SPNs 4104 through 4108
8	Verify active fault count.	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify number of active and previously active faults match in SPNs 1219 and 1219.
9	Verify monitors do not revert to not ready.	Use prior response	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify supported monitors did not change in SPNs 1221, 1222, and 1223. [CCM may be reported as ready.]
10	Verify freeze frame data.	Expanded Freeze Frame (DM25) Request Message [D]	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	Verify freeze frame data for fault if provided for CCM fault.
11	Verify MIL and Fault Cleared timers in SPNs 3069, 3294, 3295, and 3296.	Diagnostic Readiness 2 (DM21) Request Message [G]	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	Verify times remain non-zero. [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.]

§VIII Step	Test Step Objective	Stimulus	Response	Criteria
12	Verify no trip monitors revert to 'not ready'.	Diagnostic Readiness for This Trip (DM26) Request Message [G]	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	Verify readiness in SPNs 3303, 3304 and 3305. [CCM may be reported as ready].
13	Check for test results for stationary misfire on cylinder 1 – if not provided the time before.	Command Non-Continuously Monitored Test (DM7) Request Message [D]	ECU#X Response: Scaled Test Results (DM30)	Test results should be provided. [The manufacturer may define an alternate test results SPN and FMI.]
14	Verify Monitor ratios	Monitor Performance Ratio (DM20) Request Message [D]	ECU#X Response: Monitor Performance Ratio (DM20)	Verify response data is properly formatted.
15	Verify EI AECD timers	Emission Increasing- AECD Active Time (DM33) Request Message [D]	ECU#X Response: Emission Increasing- AECD Active Time (DM33)	Verify response data is properly formatted. [Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
16	Verify NTE Status	NTE Status (DM34) Request Message [G]	ECU#X Response: NTE Status (DM34) Message	Verify response data is properly formatted.
17	Wait for drive cycle completion.	The time period is defined as part of the test plan described in Section 5.		
18	Verify MIL_Status	N/A	ECU#X Active DTCs (DM1) Broadcast Message	On the first two iterations MIL_Status shall be ON. On the third iteration, MIL_Status shall be off.
19	End the key cycle.	Turn the ignition key off and wait.		[The wait time shall be identified by the manufacturer as described in paragraph 5.3.]
20	Iterate steps 1 through 17	Turn the ignition key on and start the engine. Repeat steps 1 through 18 two additional times.		
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.				

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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 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. This wait time will be defined by the manufacturer and identified as part of test planning that is identified in section 5.3.

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. When the wait time is unknown no less than two minutes shall be provided for off-line activities. 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, vehicle manufacturers may repeat process steps that they typically perform 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	Test Step Objective	Stimulus	Response	Criteria
§IX	Engine Off – Verify Engine Running Fault Clears		Verify fault remains cleared after engine off	
		Turn the engine off. Wait then turn ignition key back on and start step 1.		[The wait time shall be identified by the manufacturer as identified in paragraph 5.3.]
1	Verify MIL_Status in SPN 1213.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status in SPN 1213 stays off.
2	Verify emissions related faults.	Active Emissions- Related Faults (DM12) Request Message [G]	ECU#X Response: Active Emissions-Related Faults (DM12) Response Message	Verify there are no emissions related faults reported after the three drive cycle count in section VIII.
3	Verify pending faults.	Pending Emissions- Related Faults (DM6) Request Message [G]	ECU#X Response: Pending Emissions-Related Faults (DM6) Response Message	Verify there are no pending faults reported, as the failure was previously corrected.
4	Verify permanent faults.	Permanent DTCs (DM28) Request Message [G]	ECU#X Response: Permanent DTCs (DM28) Response Message	Verify there are no (or one) permanent faults reported.
5	Clear faults.	Clear Active Diagnostic Codes (DM11) Request Message [D]	ECU#X Response: Acknowledge Message	The system must ACK.
6	Verify MIL_Status is OFF.	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Verify MIL_Status is OFF.
7	Verify there are no emissions related faults reported.	Active Emissions- Related Faults (DM12) Request Message [D]	ECU#X Response: Active Emissions-Related Faults (DM12) Response Message	Verify there are no emissions related faults reported.
8	Verify there are no pending faults reported.	Pending Emissions- Related Faults (DM6) Request Message [D]	ECU#X Response: Pending Emissions-Related Faults (DM6) Response Message	Verify SPN 0, FMI 0, OC 0, and CM = 0 response defined in J1939-73 paragraph 5.7.6.

§IX Step	Test Step Objective	Stimulus	Response	Criteria
9	Verify permanent faults	Permanent DTCs (DM28) Request Message [D]	ECU#X Response: Permanent DTCs (DM28) Response Message	Verify there are no (or one) permanent faults reported.
10	Verify previously active emissions related DTCs	Previously Active Emissions Related DTCs (DM23) Request Message [D]	ECU#X Response: Previously Active Emissions Related DTCs (DM23) Response Message	Verify there are no previously active emissions related DTCs
11	Verify active faults	N/A	ECU#X Active DTCs (DM1) Broadcast Message	Verify there are no active faults reported.
12	Verify DTC counts in SPNs 4104 through 4108.	DTC Counts (DM29) Request Message [D]	ECU#X Response: DTC Counts (DM29) Response Message	Verify DTC counts are zeros. [The permanent fault count may equal 1.]
13	Verify active fault and previously active fault counts.	DTC Counts / Diagnostic Readiness (DM5) Request Message [G]	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify that the numbers of active and previously active faults are zero in SPNs 1218 and 1219.
14	Verify readiness	Use prior response	ECU#X Response: DTC Counts / Diagnostic Readiness (DM5) Response Message	Verify supported monitors are not ready in SPNs 1221, 1222, 1223. [CCM may be reported as ready].
15	Verify freeze frame.	Expanded Freeze Frame (DM25) Request Message [D]	ECU#X Response: Expanded Freeze Frame (DM25) Response Message	Verify there are no freeze frame results. Verify format matches DM24 display.
16	Confirm availability of supported broadcast data.	N/A	ECU#X Supported Broadcast Data	Identify each broadcast SPN from those identified in DM24.
17	Verify times and distances.	Diagnostic Readiness 2 (DM21) Request Message [D]	ECU#X Response: Diagnostic Readiness 2 (DM21) Message	Verify times and distances in SPNs 3069, 3294, 3295, and 3296 are reset to zero
18	Verify trip readiness.	Diagnostic Readiness for This Trip (DM26) Request Message [D]	ECU#X Response: Diagnostic Readiness for This Trip (DM26) Message	Verify readiness is set to not ready in SPNs 3303, 3304 and 3305. [CCM may be reported as ready]
19	Verify there are no test results.	Command Non-Continuously Monitored Test (DM7) Request Message [D]	ECU#X Response: Scaled Test Results (DM30)	Test results shall display not complete.
20	Verify Monitor ratios	Monitor Performance Ratio (DM20) Request Message [D]	ECU#X Response: Monitor Performance Ratio (DM20)	Verify response data is properly formatted.
21	Verify EI AECD timers	Emission Increasing- AECD Active Time (DM33) Request Message [D]	ECU#X Response: Emission Increasing- AECD Active Time (DM33)	Verify response data is properly formatted. [Note: Federal HD OBD engines are not required to support EI-AECDs and may NACK this request.]
22	Verify NTE Status	NTE Status (DM34) Request Message [D]	ECU#X Response: NTE Status (DM34) Message	Verify response data is properly formatted.
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 sections 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: Each ECU will need a recommended method for creating a DM12 fault.

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 sections 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 that 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. US 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 volts (i.e., nominal 12- or 24-volt 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 Section 5.2.
- f. The Test Computer will use the preferred addresses defined in SAE J1939 for an off-board diagnostic-service tool.
- g. Procedure to determine when the link drops out – Send SAE J1939 request for DM 5. 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 DM 5. 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 seconds 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 a 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 (i.e. DM5 PGN = 65230 ₁₀ , 00FECE ₁₆)	CE ₁₆
Byte 2		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 a 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 seconds 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 (i.e. DM11 - PGN = 65235 ₁₀ , 00FED3 ₁₆)	D3 ₁₆
Byte 2		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 (i.e. DM11 - PGN = 65235 ₁₀ , 00FED3 ₁₆)	D3 ₁₆
Byte 7		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 above. 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 a 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 (i.e. DM12 - PGN = 65236 ₁₀ , 00FED4 ₁₆)	D4 ₁₆
Byte 2		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 above. 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 a 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 (i.e. DM6 - PGN = 65231 ₁₀ , 00FECF ₁₆)	CF ₁₆
Byte 2		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 a 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 (i.e. DM24 - PGN = 64950 ₁₀ , 00FCB6 ₁₆)	B6 ₁₆
Byte 2		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 Stream 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 minute.

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 Sections 6.2 – 6.6 above, 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 a 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 (i.e. DM4 - PGN = 65229 ₁₀ , 00FEC ₁₆)	CD ₁₆
Byte 2		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.

7.3.1 Verify VIN

Verify the vehicle supplies one VIN.

Procedure:

- Test Computer sends a SAE J1939 request message for VIN PGN to the Global Address.

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 (i.e. Vehicle ID - PGN = 65260 ₁₀ , 00FEEC ₁₆)	EC ₁₆
Byte 2		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

Evaluation criteria:

- 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
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FIGURE 18 - VIN REFERENCE

7.3.2 Verify CAL ID

Purpose: To verify that each OBD compliant ECU provides CAL ID and CVN.

Procedure:

- Test Computer sends a request for DM19 to each OBD compliant ECU to get CAL ID and CVN.

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 (i.e. DM19 PGN = 54016 ₁₀ , 00D300 ₁₆)	00 ₁₆
Byte 2		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.
- 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 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 seconds) 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 one minute 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 (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 (i.e. DM5 - PGN = 65230 ₁₀ , 00FECE ₁₆)	CE ₁₆
Byte 2		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 does 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 seconds, 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 seconds 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 (i.e. DM6 - PGN = 65231 ₁₀ , 00FECF ₁₆)	CF ₁₆
Byte 2		FE ₁₆
Byte 3		00 ₁₆

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