SURFACE VEHICLE RECOMMENDED PRACTICE

J1939™-84	JAN2016

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Superseding J1939-84 FEB2015

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

RATIONALE

This version of SAE J1939-84 improves the February 2015 version by improving language that relies upon contextual technical details in referenced documents. An Engine Serial Number evaluation was added to sections 6.1 and 6.2. Wait times for fault erasure using DM3 and DM11 were increased to 5 seconds. The transition between part 7 and part 8 was improved to better assure that DM28 tests don't experience a false positive outcome. Section A.6 was improved to separate evaluation of readiness bits provided by OBD modules from non-supported DM5 data provided by non-OBD modules. Data in Table A.7 reflects the content of SAE J1939-DA of February 2015. Section A.10 was added to describe processing for PGNs that are only supported by some of the OBD modules under test.

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 between an off board diagnostic tool (i.e., scan tool) and a vehicle or component fulfill certain on-board diagnostic (OBD) regulatory requirements for 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 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, methods, and results for verifying diagnostic communications 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 user should reference the summary provided by SAE J1939-73 Table 1 and Table 2 for OBD compliance support.

The February 2015 version of SAE J1939-84 replaced the test procedures in section 6 in order to implement a 2-operating cycle failure detection process for Production Vehicle Evaluation (I)(1) as requested by ARB. The tests also exercise diagnostic executive features such as three drive cycle accounting, freeze frame management and the general denominator in addition to the demonstration of interface function. Detailed criteria for some tests are described in a normative appendix, Appendix A, which was inserted before the output report examples that are now in Appendix B.

The December 2008 publication of J1939-84 described a test process for EURO IV and EURO V engine emissions and diagnostics regulations which is given in section 7. The December 2010 version of the document added a test plan and procedure outline for ARB and US EPA HD OBD requirements with emphasis on 13 CCR 1971.1 (I)(1) Verification of Standardized Requirements, as section 6. The June 2012 version added the observation of the MIL_On to MIL_Off transition for a single trip CCM fault and reformatted tables in section 6 to improve ease of use.

2. REFERENCES

At the time of publication there are no known conflicts between this specification, 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 indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (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, 250Kbps, Twisted Shielded Pair

SAE J1939-13 Off-Board Diagnostic Connector

SAE J1939-14 Physical Layer, 500Kbps

SAE J1939-15 Physical Layer, 250Kbps, Un-Shielded Twisted Pair (UTP)

SAE J1939-21 Data Link Layer

SAE J1939-71 Vehicle Application Layer

SAE J1939-73 Application Layer - Diagnostics

SAE J1939-81 Network Management

SAE J1939DA J1939 Digital Annex

2.1.2 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, including 13 CCR 1968.1.

2.1.3 United States Federal Regulations:

Available from the Government Printing Office at www.gpo.gov.

Title 49 CFR Part 565 Subpart B - VIN Requirements

Simon, Karl, CSID-07-03, “EPA Standardized Naming Conventions for Model Year 2009 and Later Engine Family and Test Group Names, Evaporative-Refueling Family Names, and Permeation Family Names”, US EPA, 2007.

Available from US EPA at http://iaspub.epa.gov/otaqpub/publist_gl.jsp?guideyear=2007

2.2 Related Publications

The following publications are provided 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 +1 724-776-4970 (outside USA), www.sae.org.

SAE J1699®-3 OBD II Compliance Test Cases

SAE J1699-3 is a registered trademark of SAE, International.

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

2.3 Other Publications

2.3.1 ATA Technology and Maintenance Council [TMC] Recommended Engineering Practices Manual:

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

TMC RP1210 C 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

3.1.1 Drive Cycle

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

3.1.2 Failure

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

3.1.3 Test Computer or Test Tool

Equipment used to generate and monitor tests and messages.

3.1.4 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
DM	Diagnostic Message
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
KOEO	Key On Engine Off
KOER	Key On Engine Running
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
SCC	Since Code Clear
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, J1939DA 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. In addition to vehicle integration, Section 6 test results provide evidence for the proper or improper operation of certain aspects of an HD OBD diagnostic executive. Test requirements in section 7 are focused on OBD regulations that preceded 13 CCR 1971.1.

Figure 1 abstracts a SAE J1939 network on the vehicle, which comprises the system under test. The network is exercised by the test computer using a compatible CAN interface for SAE J1939 communications. The test computer and the vehicle's SAE J1939 network exchange data using pins C and D of 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 RP1210C API for PVE testing is highly desirable.

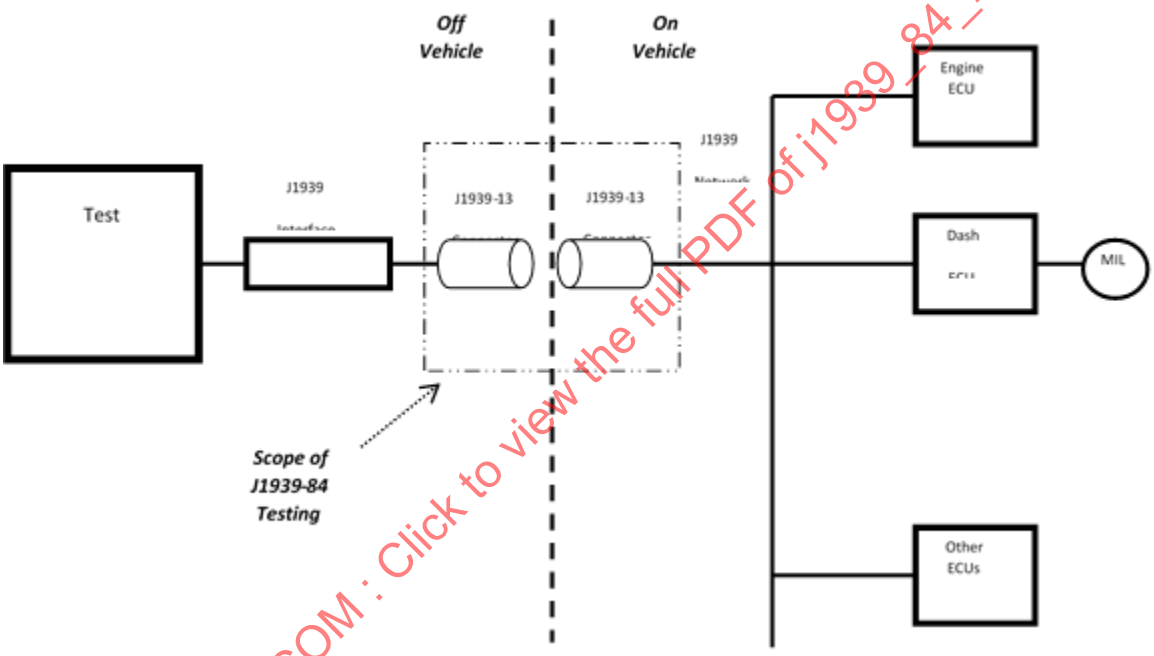

Figure 1 – SAE J1939-84 Test scope overview

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 (l)(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 recommend faults to provide content for diagnostic message responses that are demonstrated in sections 6 and 7. Section 6 requires two separate, distinct faults. At least one of the two faults for section 6 must be detected across two operating cycles. Faults that are detected in a single ignition key cycle without driving the vehicle or running the engine are recommended for section 7. These recommendations must provide clear instructions for initiating the fault and its subsequent repair. For section 7, 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 SAE 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 purpose of PVE regulation testing. For example, they may be used to evaluate the integration of new (powertrain) components on the vehicle or engine. Adaptation of these procedures for other purposes is the responsibility of the user.

4.4 Document Overview

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

5. TEST CONDITIONS, TEST PLANNING, AND COMMUNICATION CAPABILITIES

This section discusses common test conditions for the vehicle, information requirements for test planning, 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. These non-OBD ECUs may also provide DM5 responses that contain their active and inactive fault counts.

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". HD OBD systems must provide responses to DM1 and DM2 as discussed in section 6. Some incomplete vehicles may detect failures for equipment that is to be installed during a later stage of vehicle manufacture for the vehicle vocational 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. Tests shall begin with a well charged battery. 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. Test conditions other than those described in SAE J1939-73 paragraph 5.2.3 General Diagnostic Conditions may lead to unexpected results.

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 – what is the desired vehicle model, engine displacement, engine family (includes CAL-ID and communications baud rate), transmission, brake, and other equipment selections for the test?
- 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?
- Vehicle Hot/Cold temperature conditioning – are there 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?
- Methods recommended to demonstrate MIL_Status – How does the technician implant the fault(s)? Test procedures assume that the method(s) will implant a continuous component monitoring fault(s).
    - The process in section 6 requires that a method will induce at least one two trip continuous monitoring fault. Section 7 assumes that the method will induce a single trip continuous component monitoring fault. Methods that elicit two distinct DTCs are required for section 6's demonstration of freeze frame content, permanent fault erasure and the general denominator.
    - The sensors used by the method should be readily accessible for the test technician to disconnect, and faults should be detected as failures within an efficient time frame.[1] The recommended method shall support operating 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.
- Operator controls settings for demonstrating MIL Status and the General Denominator – what are the desired settings for the operator's controls during the test steps?
- Distributed systems effects – what are the distributed elements of the emissions control system and its HD OBD monitoring system? Which elements provide independent support for HD OBD communication requirements?
- DM2 – Previously Active Diagnostic Trouble Codes approach – Must vehicles having DM2 faults be excluded from providing certification data? Do ECU(s) comprising the OBD system also support DM2? Which, if any, non-emissions related DTCs may also be reported using DM2 during the test procedure? Sections 6 and 7 assume that the vehicle begins the test with no active or inactive faults.
- Waiting Time – How long should a technician wait in between test parts for ECM processes that managing OBD and other data? How long does it take for the recommended faults to mature? Section 6 provides some recommendations for waiting times – exceptions need to be noted for technicians to successfully administer tests.
- Specific DTCs for inquiry into test results – which DTCs will provide scaled test results [for use in section 7] 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?

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 6.13 discusses additional tailoring considerations for the HD OBD test procedure.

[1] Faults, that result from monitors which are subject to minimum ratio requirements in 13 CCR 1971.1 (d), are not recommended for use in SAE J1939-84 testing.

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 using regulations authorized by ARB in August 2012. 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. The test equipment will be connected via the SAE J1939-13 diagnostic connector. When tests are conducted on vehicles with faults (or emissions-related pending 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, and the evaluation of fault counts will fail. Section 6 tests require that DM1 and DM2 message responses display HD OBD defined faults during the test sequence.

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, SAE J1939-14 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 1210C.

5.4.3 Message Format

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

5.4.4 Message Timing

The test computer shall be capable of measuring the response time to an accuracy of at least 1 ms. The message response timing is specified in SAE J1939-21. Section 6 interprets SAE J1939-21 timing requirements to better suit anticipated test conditions and vehicle configurations.

5.4.5 Throughput Capacity

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

5.4.6 Storage Capacity

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

6. HD OBD TEST PLAN AND PROCEDURES

Section 6 describes the test procedure for engines and vehicles subject to ARB's HD OBD regulation 13 CCR 1971.1, paragraph (l)(1). Figure 2 below shows the overall general sequence of section 6 tests in the form of a signal chart. This chart shows the key required displays for the 12 test parts. Those test parts that require more than one operating cycle are noted by the double arrows in the figure and the suffixed letters a and b behind the part number.

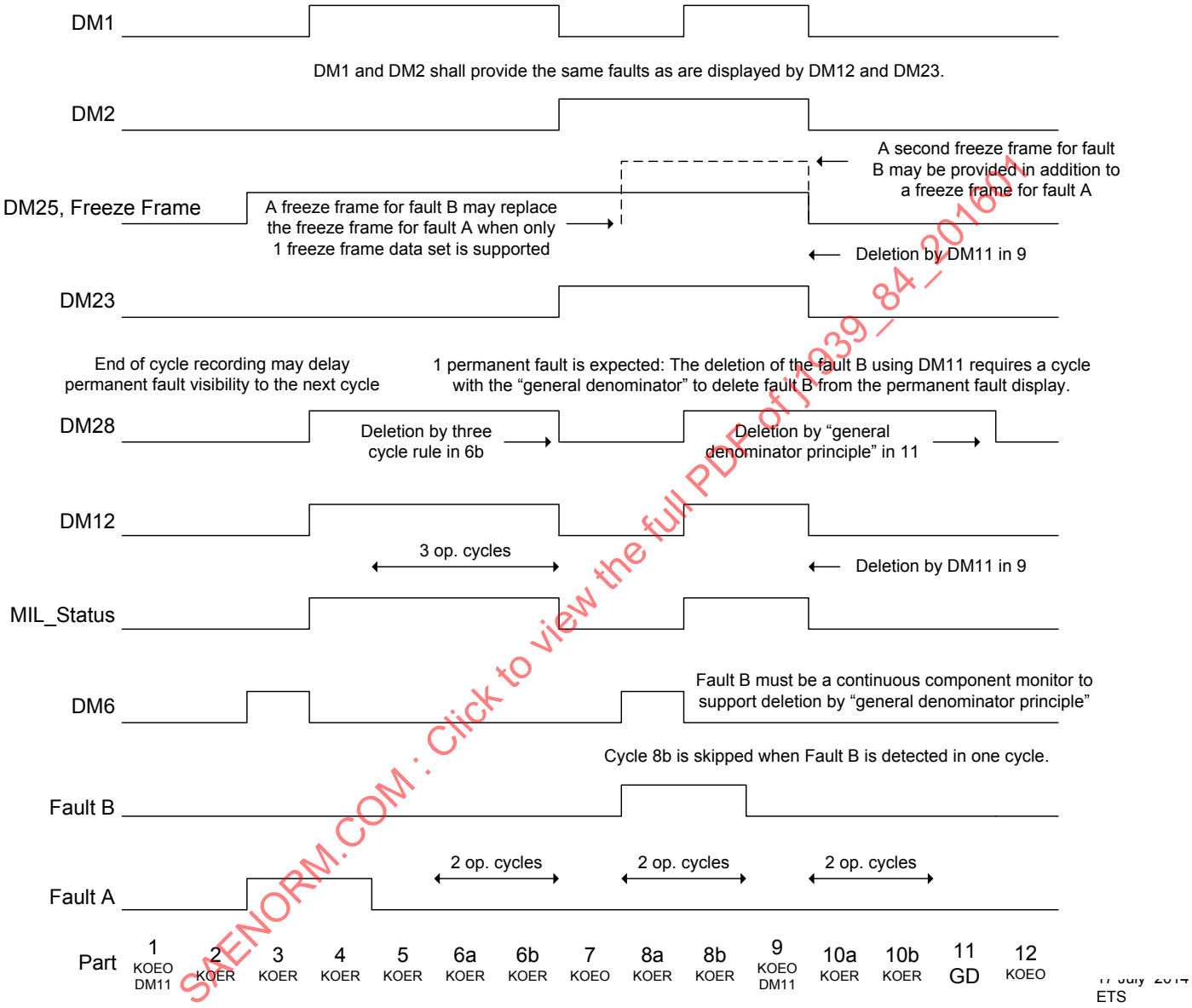

Figure 2 - SAE J1939-84 test process overview

The goal of section 6 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 two faults recommended by the manufacturer. Fault A as shown in Figure 2 must require two operating cycles for detection. Fault B as shown in Figure 2 must be a Comprehensive Component Monitoring (CCM) fault, which may require one or two operating cycles for detection.

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). Table 1 identifies twelve test parts for PVE testing, explaining the test objectives for each part. These test parts are provided in sections 6.1 through 6.12, respectively. Section 6.13 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 – Summary test plan for HD OBD PVE

Test Part	Test Part Objectives	Test Part Summary
1	*Key On Engine Off – Data Collection*	*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*.	The request for DM11 shall succeed to establish initial conditions for subsequent test sections. Only vehicles with no active faults (DM1), no pending faults (DM6), and no confirmed faults (DM12) should proceed with part 2.
2	*Engine Running – Data Collection*	*Verify Running Engine Provides Required Data*
	Verify data collection on a vehicle with no known faults with the engine running.	Verify the engine control system configuration and data collection to 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 part 3.
3	*Engine Running – Test Pending Fault A*	*Verify Engine Running System Response to Fault A.*
	Verify HD OBD system response to a CCM failure while the engine is running. Fault A in Figure 2 shall be displayed as a pending fault in DM6	The vehicle shall report the CCM failure in DM6 according to 13 CCR 1971.1. The engine manufacturer shall recommend circuits that can readily be disconnected while the engine is off to provide the 2-trip failure stimulus for these tests.
4	*Engine Running – Test Confirmed Fault A*	*Verify Engine Running System Response to Fault Trip 2*
	Verify HD OBD MIL On Confirmed Fault (DM12) for Fault A.	The vehicle shall report the CCM failure in DM12 according to 13 CCR 1971.1. The CCM failure shall not be displayed in DM6. [The fault will not be seen in DM6 as pending faults must be deleted within 10 s per 13 CCR 1971.1 (d)].
5	*Engine Running – Correct Fault A First Cycle*	*Verify Behavior with Fault Removed*
	Verify OBD system response to the correction of Fault A	Repair implanted CCM fault and start 3 Cycle count down for DM12 to DM23 transition. The failure shall still be displayed in DM12 [and DM28], as three (drive) cycles have not yet occurred.
6	*Engine Running – Complete Fault A Three Cycle Countdown*	*Verify Three Cycle Countdown trips 2 and 3.*
	Complete cycles 2 and 3 of the 3 cycle countdown.	The MIL shall remain on and the vehicle shall continue to report the failure in DM12 according to 13 CCR 1971.1.
7	*Key On Engine Off – Verify DM23 Transition*	*Verify System Behavior with Fault Removed*
	Verify that the fault transitioned to DM23 and the permanent fault was deleted in DM28.	The DTC displayed in DM23 must match the DTC displayed in prior DM6 and DM12 displays. The 3 cycle rule shall have deleted the permanent fault.

Table 1 - Summary test plan for HD OBD PVE (continued)

Test Part	Test Part Objectives	Test Part Summary
8	*Engine Running – Verify Fault B for General Denominator Demonstration.*	*Verify Implanted Fault B and Check Fault Displays*
	Implant 2nd fault for the general denominator demonstration and verify confirmed code display.	Fault B shall be observed in DM12, and Fault A shall be observed in DM23.
9	*Key On Engine Off – Verify Deletion of Fault B with DM11.*	*Verify Retention of Permanent Fault*
	Verify DM11 erasure of Fault B in DM23 but not its existing permanent fault.	Turn engine off, repair fault and verify fault displays, then clear faults (DM11). Fault B must still be reported using DM28.
10	*Engine Running – Prime Diagnostic Executive for General Denominator Demonstration*	*Prepare for General Denominator Demonstration*
	Complete two operating cycles after the DM11 clear in Section 10.	Two operating cycles are provided prior to the general denominator demonstration to erase the 2nd permanent fault.
11	*Engine Running – Exercise General Denominator*	*Demonstrate General Denominator*
	Demonstrate achievement of general denominator on a stationary vehicle.	A permanent fault is displayed in DM28. The DM20 display of the general denominator shall be observed to increment. This allows the permanent fault deletion in DM28 to be assessed in part 12.
12	*Key On Engine Off – Verify Deletion of Fault B from DM28*	*Verify Fault B is erased in DM28.*
	Demonstrate the erasure of a permanent fault as the general denominator criteria had been met. Evaluate DM11 requirements.	The permanent fault for Fault B shall not be displayed. Destination Specific DM11 requests must not delete data. The global DM11 request shall succeed.

The test procedures for parts 1 through 12 are written based on the following provisions and conventions.

I. Outline Format – part 1 through part 12 procedures are written using an outline format as shown below

   A. 6.X Part X

   B. 6.X.Y Test Y of Part X

   C. 6.X.Y.Z Step Z of Test Y

      The subsection number X identifies the part in the overall test sequence. The paragraph number Y identifies Test Y in Part X. And, the subparagraph number Z identifies Step Z within Test Y of Part X. An alphabetic enumeration is provided within subparagraphs, this enumeration allows individual criteria to be discussed, where there is more than one action or failure criterion.

II. Compliance to SAE J1939-21 and SAE J1939-73 – Query procedures and responses are subject to the provisions given in SAE J1939-21 and SAE J1939-73. These provisions are subject to the convention that the communication facilities for destination specific response, that is the RTS/CTS facilities and TP.DT buffers, shall not be busy supporting other network communication needs for more than one second while the SAE J1939-84 test is being administered.

   A. Individual requests in the procedures below are shown as having either a global destination address, indicated by “Global”, or a destination specific request, indicated by “DS”. Destination specific requests will typically be sent to those OBD ECUs that respond to a global request for DM5 with a value that indicates compliance to an OBD regulation. [See section A.6 for values that indicate HD OBD is supported].

B. Queries shall not overlap to the same device within a single timeout period. SAE J1939-21 Request queries shall not overlap each other or queries for test results using DM7. Queries for test results using DM7 shall not overlap each other or queries for other data requested using the SAE J1939-21 request PGN. When the anticipated responses from OBD devices have been received, the test tool need not wait for 1200 ms before proceeding with the next query, but may proceed with the next query in the test sequence, except when a NACK with a control byte value of 3 “Busy” is received, then the provisions of E. below shall preside within the 1200 ms overall response time provided by SAE J1939-21.

C. SAE J1939-73 limits the use of request queries for some multi-packet data and DM7 queries to destination specific addressing.[2] Globally addressed requests are not used for DM24, DM25 and others.

D. SAE J1939-21 defines query timeouts and provides for two retries of a given information request. Warnings may be provided for responses that exceed 200 ms. Globally addressed queries shall be accorded two retries. Destination specific queries shall be accorded retries only when the acknowledgement control byte value of 3 “Busy” is received. The multiple response time periods for the RTS/CTS transport protocol shown in SAE J1939-21 Figure C1 shall be individually observed.

E. An acknowledgement PGN control byte value of 3 “Busy” may be received instead of the requested data for a query.

1. If the original request was a global request, the tool shall retry at least once using a destination specific request addressed to the ECU that provided the busy response. The destination specific acquisition of the data shall be accepted with a warning. The tool shall retry the request at least one additional time (for a total of 4 times) when a control byte value of 3 has been received.

2. If the original request was a destination specific request, the tool shall retry using only destination specific requests with a period no more frequent than 200 ms until at least one second has elapsed from the original query to the last request, or until the ECU responds with the requested data, or until the ECU stops responding with the control byte value of 3 “Busy”. Data that is received within the 1.2s overall timeout provision shall be accepted with no warning or failure message. Data that is not received may be deemed to have timed out and the ECU shall be identified as having failed the test for the given request.

F. The acknowledgement PGN provides the identification of the request in the PGN data field. The data in the field shall be matched to the data in the request along with the address of the sender when an ACK or NACK is used to determine pass or failure outcomes.

III. Assessment of Optional Diagnostic Messages – Several query evaluation criteria are marked with the term “(if supported)”. The criteria listed for these queries represent optional content that is at the discretion of the manufacturer to provide, as shown in SAE J1939-73 Tables 1 and 2. Vehicles and engines shall pass a test when there are no responses provided for queries marked as “(if supported)”.

A. A NACK shall be provided for destination specific requests when the PGN field is not supported.

B. The minimum timeout of 200 ms shall be observed between queries when there is no response whether positive (the requested PGN), ACK or NACK for a given query.

IV. Assessment of Optional Data Values in a Diagnostic Message - When the term “if supported” is applied to the value of a single SPN, the test shall pass if the SPN is provided as 0xFF, or Not Available, as defined in SAE J1939-71 section 5.

[2] Some global queries for multi-packet data can exhaust SAE J1939-21 TP.DT resources for minutes. The limitations defined in SAE J1939-73 are intended to avoid such conditions.

V. Non-Response Failure Convention – The enumerated failure criteria presume that missing responses that are not allowed under III shall be interpreted as failures. A minimum of one positive response is required from the vehicle. A NACK shall be provided for destination specific requests when the PGN field is not supported by an ECU. An acknowledgement PGN with a control byte value of 1 (not acknowledgement) is not an automatic disqualification for a given query. Partitioned systems will feature ECUs that do not support many of the queried SAE J1939-73 messages. These ECUs will send a control byte value of 1 for those required PGNs that another ECU supports for compliance with 13 CCR 1971.1 (h) communications provisions when queried using the destination specific form of Request [PGN 59904]. When they do not support the PGN, such ECUs do not respond to the global form of Request for that PGN. See Section A.10 for an example set of evaluation criteria.

VI. Referenced Detailed Criteria – Many test steps refer to detailed criteria defined in Appendix A sections. For example section A.3 identifies the calculations required to evaluate a VIN. When assessing the data for MIL_Status (and Flash MIL Status), section A.8 provides the allowed values for MIL_Status (SPN 1213) and Flash Malfunction Indicator Lamp (SPN 3038) according to Table 5 of SAE J1939-73.

VII. All responses provided during developmental testing are subject to section 5.3.4.

6.1 Part 1 KOEO Data Collection

Part 1 Purpose: Verify data in key-on, engine off (KOEO) mode and clear codes to begin test from known starting point.

6.1.1 Test vehicle data collection

6.1.1.1 Actions:

a. Confirm the vehicle is in a safe location and condition for the test.

b. Confirm that the vehicle battery is well charged. [Battery voltage >> 12 volts].

c. Confirm the vehicle condition and operator control settings according to the engine manufacturer's instructions.

d. Turn the ignition key to on.

e. Record vehicle data base entries including:

   i. VIN of vehicle,

   ii. MY of engine,

   iii. MY of vehicle,

      1. Warn the user if the MY character of the VIN does not match the data entered by the user for the vehicle model year.

   iv. Fuel type,

   v. Number of emission or diagnostic-critical control units on vehicle (i.e., number that are required to support CAL ID and CVN),[3] and

   vi. Certification intent (US, Euro, etc.)

[3] The number provided by the user must be greater than zero, or the vehicle may not be intended to comply with HD OBD or EOBD provisions. DM19 test criteria assume this value is greater than zero.

6.1.2 Verify engine operation

6.1.2.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.1.2.2 Warn criteria:

a. If engine speed is > 0 rpm, prompt/warn operator to confirm engine is not running.

6.1.3 DM5: Diagnostic readiness 1

6.1.3.1 Actions:

a. Global[4] DM5 (send Request (PGN 59904) for PGN 65230 (SPN 1220)).

b. Create 'OBD ECU'[5] list (comprised of all ECUs that indicate 0x13, 0x14, 0x22, or 0x23 for OBD compliance) for use later in the test as the “OBD ECUs”.

6.1.3.2 Fail criteria:

a. Fail if no ECU reports as an OBD ECU.

b. Fail if any ECU responds with a NACK (for PGN 65230).

6.1.3.3 Warn criteria:

a. Warn if more than one ECU responds with a value for OBD compliance where the values are not identical (e.g., if one ECU reports 0x13 and another reports 0x22, if one reports 0x13 and another reports 0x11).

6.1.4 DM24: SPN support

6.1.4.1 Actions:

a. Destination Specific (DS) DM24 (send Request (PGN 59904) for PGN 64950 (SPNs 3297, 4100-4103)) to each OBD ECU.[6]

b. Create vehicle list of supported SPNs for data stream.

c. Create ECU specific list of supported SPNs for test results.

d. Create ECU specific list of supported freeze frame SPNs.

6.1.4.2 Fail criteria:[7]

a. Fail if one or more minimum expected SPNs for data stream not supported per section A.1, Minimum Support Table, from the OBD ECU(s).

b. Fail if one or more minimum expected SPNs for freeze frame not supported per section A.2, Criteria for Freeze Frame Evaluation, from the OBD ECU(s).

[4] Always record any NACK or ACK received for requests, by using the PGN data field to match the ACK or NACK to the request. See Roman numerals II, III, IV, and V prior to section 6.1 for more information about ACKs and NACKs and other referenced requirements given in SAE J1939-21.
[5] ‘OBD ECU’ means an ECU reporting 0x13 (19), 0x14 (20), 0x22 (34), or 0x23 (35) for OBD compliance in DM5. Devices that respond with 0x05 or 0xFF imply that they are not intended to comply with HD OBD requirements. Always warn if a response from a non-OBD ECU is being used/received/evaluated anytime in test.
[6] Timeout provisions for this and other RTS/CTS transport protocol responses shall follow SAE J1939-21 Figure C1.
[7] Minimum test result coverage is assessed in step 6.1.11 according to section A.7.

6.1.5 PGN 65260 VIN verification

6.1.5.1 Actions:

a. Global Request (PGN 59904) for PGN 65260 Vehicle Id (SPN 237) VIN[8]

6.1.5.2 Fail criteria:

a. Fail if no VIN is provided by any ECU.

b. Fail if more than one OBD ECU responds with VIN.

c. Fail if VIN does not match user entered VIN from earlier in this Section.

d. Fail if 10th character of VIN does not match model year of vehicle (not engine) entered by user earlier in this part.

e. Fail per section A.3, Criteria for VIN Validation.

6.1.5.3 Warn criteria:

a. Warn if VIN response from non-OBD ECU

b. Warn if more than one VIN response from any individual ECU.[9]

c. Warn if VIN provided from more than one non-OBD ECU.

d. Warn if manufacturer defined data follows the VIN.

6.1.6 DM56: Model year and certification engine family

6.1.6.1 Actions:

a. Global DM56 (send Request (PGN 59904) for PGN 64711 (SPNs 5844 and 5845)).

6.1.6.2 Fail criteria (if supported):[10]

a. Fail if engine model year does not match user input.

b. Fail if indicates “V” instead of “E” for cert type.

c. Fail if not formatted correctly (e.g., “2013E-MY” is correct format so fail if doesn’t have xxxxE-MY with xxxx matching MY entered by user or any difference to “E-MY”).

d. Fail if MY designation in engine family (1st digit) does not match user MY input.[11]

e. Fail if engine family has <> 12 characters before first asterisk character (ASCII 0x2A) or “null” character (ASCII 0x00).

[8] The use of global requests in tests will require a capable data link adapter to be able to handle multiple transport sessions. Additionally the global response will take a fair amount of time due to packet separation requirements (50-200 ms separation).
[9] Users are expected to explain the cause for the additional VIN displays, even as warnings and not failures. This includes both an OBD ECU and a non-OBD ECU each providing a VIN, and more than one non-OBD ECU providing a VIN. This can be accomplished with a count of responses considering their individual source addresses. Failure criteria c, d and e shall be applied to each VIN received.
[10] “If supported” is used for DMs and SPNs that are not required to be implemented but are tested for accurate information only if they are supported/implemented by one or more ECUs. When used, this indicates that it is acceptable for one or more ECUs to not support this DM (i.e., to NACK for destination specific requests and no response for global requests). But for ECUs that do respond, the fail and warn criteria should be applied.
[11] See the citation for Karl Simon’s manufacturer guidance in 2.1.3. The description of the coding for engine model year is defined in CSID-07-03, a manufacturer letter that is available from US EPA at http://iaspub.epa.gov/otaqpub/publist_gl.jsp?guideyear=2007

6.1.7 DM19: Calibration information

6.1.7.1 Actions:

a. Global DM19 (send Request (PGN 59904) for PGN 54016 (SPNs 1634 and 1635)).

b. Create list of ECU address + CAL ID + CVN. [An ECU address may report more than one CAL ID and CVN].

c. Display this list in the log.

6.1.7.2 Fail criteria:

a. Fail if total number of reported CAL IDs is < user entered value for number of emission or diagnostic critical control units (test 6.1.2).

b. For responses from OBD ECUs:

   i. Fail if <> 1 CVN for every CAL ID.

   ii. Fail if CAL ID not formatted correctly (printable ASCII, padded incorrectly, etc).

   iii. Fail if any received CAL ID is all 0xFF or any CVN is all 0x00.

   iv. Fail if CVN padded incorrectly (must use 0x00 in MSB for unused bytes)

6.1.7.3 Warn criteria:

a. Warn if total number of reported CAL IDs is > user entered value for number of emission or diagnostic critical control units (test 6.1.2).

b. Warn if more than one CAL ID and CVN pair is provided in a single DM19 message.

c. For responses from non-OBD ECUs:

   i. Warn if any non-OBD ECU provides CAL ID.

   ii. Warn if <> 1 CVN for every CAL ID.

   iii. Warn if CAL ID not formatted correctly (contains non-printable ASCII, padded incorrectly, etc.).

   iv. Warn if any received CAL ID is all 0xFF or any CVN is all 0x00.

   v. Warn if CVN padded incorrectly (must use 0x00 in MSB for unused bytes).

6.1.7.4 Actions2:

a. Destination Specific (DS) DM19 to each OBD ECU (plus all ECUs that responded to global DM19).

6.1.7.5 Fail criteria2:

a. Compare to ECU address + CAL ID + CVN list created from global DM19 request and fail if any difference.

b. Fail if NACK (PGN 59392) with mode/control byte = 3 (busy) received.[12]

c. Fail if NACK not received from OBD ECUs that did not respond to global query.

[12] 13 CCR 1971.1 (h)(4.7.5) allows for delayed timing during the first 120 s of operation after memory has been 'reprogrammed'. This procedure assumes that the allowed 120 s has already expired.

6.1.8 DM20: Monitor Performance Ratio

6.1.8.1 Actions:

a. Global DM20 (send Request (PGN 59904) for PGN 49664 (SPNs 3048, 3049, 3066-3068).

   i. Create list by ECU address of all data for use later in the test.

6.1.8.2 Fail criteria:

a. Fail if minimum expected SPNs are not supported (in the aggregate response for the vehicle) per section A.4, Criteria for Monitor Performance Ratio Evaluation.

6.1.9 Component ID: Make, Model, Serial Number Support

6.1.9.1 Actions:

a. Destination Specific (DS) Component ID request (PGN 59904) for PGN 65259 (SPNs 586, 587, and 588) to each OBD ECU.

b. Display each positive return in the log.

6.1.9.2 Fail Criteria:

a. Fail if there are no positive responses (serial number SPN 588 not supported by any OBD ECU).

b. Fail if none of the positive responses are provided by the same SA as the SA that claims to be function 0 (engine). (SPN 588 ESN not supported by the engine function).

c. Fail if the serial number field (SPN 588) from any function 0 device does not end in 6 numeric characters (ASCII 0 through ASCII 9).

d. Fail if the make (SPN 586), model (SPN 587), or serial number (SPN 588) from any OBD ECU contains any unprintable ASCII characters.[13]

   See Section A.1 for detailed examples of failure and warning criteria.

6.1.9.3 Warn Criteria for OBD ECUs:

a. Warn if the serial number field (SPN 588) from any function 0 device is less than 8 characters long.

b. Warn if the make field (SPN 586) is longer than 5 ASCII characters.

c. Warn if the make field (SPN 586) is less than 2 ASCII characters.

d. Warn if the model field (SPN 587) is less than 1 character long.

6.1.9.4 Actions2:

a. Global Component ID request (PGN 59904) for PGN 65259 (SPNs 586, 587, and 588).

b. Display each positive return in the log.

[13] Unprintable ASCII characters include those characters [numerically] less than ASCII 20 (space).

6.1.9.5 Fail Criteria2 for function 0:

a. Fail if there is no positive response from function 0. (Global request not supported or timed out)

b. Fail if the global response does not match the destination specific response from function 0.

6.1.9.6 Warn Criteria2 for OBD ECUs other than function 0:

a. Warn if Component ID not supported for the global query in 6.1.9.4.

6.1.10 DM11: Diagnostic Data Clear/Reset for Active DTCs

6.1.10.1 Actions:

a. Global DM11 (send Request (PGN 59904) for PGN 65235).

b. Record all ACK/NACK/BUSY/Access Denied responses (for PGN 65235) in the log.

c. Allow 5 s to elapse before proceeding with test step 6.1.9.2.

6.1.10.2 Fail criteria:

a. Fail if NACK received from any HD OBD ECU.

b. Fail if any diagnostic information in any ECU is not reset or starts out with unexpected values. Diagnostic information is defined in section A.5,_Diagnostic Information Definition.[14]

6.1.10.3 Warn criteria:

a. Warn if ACK received from any HD OBD ECU.[15]

6.1.11 DM21: Diagnostic readiness 2

6.1.11.1 Actions:

a. Global DM21 (send Request (PGN 59904) for PGN 49408 (SPNs 3069, 3294-3296)).

6.1.11.2 Fail criteria:

a. Fail if any ECU reports distance with MIL on (SPN 3069) is not zero.

b. Fail if any ECU reports distance SCC (SPN 3294) is not zero.

c. Fail if any ECU reports time with MIL on (SPN 3295) is not zero (if supported).[16]

d. Fail if any ECU reports time SCC (SPN 3296) > 1 minute (if supported).

e. Fail if no OBD ECU provides a DM21 message.

[14] Checks for erased data shall at a minimum include those queries provided in the same test part. Section A.5 provides for all the data that can be checked.
[15] Some ECUs support DM11 by fulfilling or denying the command, then ACKing or NACKing the globally requested operation, because DM11 permanently alters ECU memory values.
[16] When “if supported” is indicated for a given SPN the data provided may be all binary ones instead of an enumerated or scaled value. Bit patterns that indicate other conditions may be considered to be a failure. See SAE J1939-71 for presentation layer conventions in SPN data.

6.1.11.3 Actions2:

a. DS DM21 to each OBD ECU.

6.1.11.4 Fail criteria2:

a. Fail if any ECU reports distance with MIL on (SPN 3069) is not zero.

b. Fail if any ECU reports distance SCC (SPN 3294) is not zero.

c. Fail if any ECU reports time with MIL on (SPN 3295) is not zero (if supported)

d. Fail if any ECU reports time SCC (SPN 3296) > 1 minute (if supported).

e. Fail if any responses differ from global responses.

f. Fail if NACK not received from OBD ECUs that did not respond to global query. [17]

6.1.12 DM7/DM30: Command Non-continuously Monitored Test/Scaled Test Results

6.1.12.1 Actions:

a. DS DM7 with TID 247 using FMI 31 for each SPN identified as providing test results in a DM24 response In step 6.1.4.1 to the SPN's respective OBD ECU. Create list of ECU address+SPN+FMI supported test results.[18]

6.1.12.2 Fail/warn criteria:

a. Fail/warn per section A.7 Criteria for Test Results Evaluation.

6.1.13 DM5: Diagnostic Readiness 1: Monitor Readiness

6.1.13.1 Actions:

a. Global DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1218-1223)).

b. Display monitor readiness composite value in log for OBD ECU replies only.

6.1.13.2 Fail/warn criteria:

a. Fail/warn per section A.6, Criteria for Readiness 1 Evaluation.

b. Fail if any OBD ECU reports active/previously active fault DTCs count not = 0/0.

c. Fail if no OBD ECU provides DM5 with readiness bits showing monitor support.

d. Warn if any individual required monitor, except Continuous Component Monitoring (CCM) is supported by more than one OBD ECU.

6.1.13.3 Actions2:

a. DS DM5 to each OBD ECU.

[17] An ECU that does not support a given PGN will not respond to a global request and shall NACK destination specific requests, as described in SAE J1939-21. These responses are equivalent; both deny the availability of the requested data from the ECU. Additional comments regarding SAE J1939-21 precede part 1 step 1.

[18] Test results are expected only from the OBD ECU that listed the SPN with test results supported in its DM24 response. Global queries (DM7 messages) for test results can oversubscribe TP.BAM resources.

6.1.13.4 Fail criteria:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.1.14 DM26: Diagnostic readiness 3

6.1.14.1 Actions:

a. Global DM26 (send Request (PGN 59904) for PGN 64952 (SPNs 3301-3305)).

   i. Create list by ECU address of all data and current status for use later in the test.

b. Display monitor readiness composite value in log for OBD ECU replies only.

6.1.14.2 Fail criteria:

a. Fail if any response for any monitor supported in DM5 by a given ECU is reported as '0=monitor complete this cycle or not supported' in SPN 3303 bits 1-4 and SPN 3305 [except comprehensive components monitor (CCM)].

b. Fail if any response for each monitor not supported in DM5 by a given ECU is not also reported in DM26 as '0=monitor complete this cycle or not supported' in SPN 3303 bits 5-7 and '0=monitor disabled for rest of this cycle or not supported' in SPN 3303 bits 1-2 and SPN 3304.[19]

c. Fail if any response from an ECU indicating support for CCM monitor in DM5 reports '0=monitor disabled for rest of this cycle or not supported' in SPN 3303 bit 3.

d. Fail if any response indicates number of warm-ups since code clear (WU-SCC) (SPN 3302) is not zero.

e. Fail if any response indicates time since engine start (SPN 3301) is not zero.

f. Fail if no OBD ECU provides DM26.

6.1.14.3 Warn criteria:

a. Warn if any individual required monitor, except Continuous Component Monitoring (CCM) is supported by more than one OBD ECU.

6.1.14.4 Actions:

a. DS DM26 to each OBD ECU.

6.1.14.5 Fail criteria:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.1.15 DM1: Active diagnostic trouble codes (DTCs)

6.1.15.1 Actions:

a. Gather broadcast DM1 data from all ECUs (PGN 65226 (SPNs 1213-1215, 1706, and 3038)).

[19] Bit 1 is the cold start monitor; initial temperature conditions may play a role in the displays for this monitor.

6.1.15.2 Fail criteria:

a. Fail if any OBD ECU reports an active DTC.

b. Fail if any OBD ECU does not report MIL off. See section A.8 for allowed values [20]

c. Fail if any non-OBD ECU does not report MIL off or not supported MIL status (per SAE J1939-73 Table 5).

d. Fail if any OBD ECU reports SPN conversion method (SPN 1706) equal to binary 1.

e. Fail if no OBD ECU provides DM1

6.1.15.3 Warn criteria:

a. Warn if any ECU reports the non-preferred MIL off format. See section A.8 for description of (0b00, 0b00).

b. Warn if any non-OBD ECU reports SPN conversion method (SPN 1706) equal to 1.

6.1.16 DM2: Previously Active Diagnostic Trouble Codes (DTCs)

6.1.16.1 Actions:

a. Global DM2 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 3038, 1706)).

6.1.16.2 Fail criteria (if supported):

a. Fail if any OBD ECU reports a previously active DTC.

b. Fail if any OBD ECU does not report MIL off.

c. Fail if any non-OBD ECU does not report MIL off or not supported.

6.1.16.3 Actions2:

a. DS DM2 to each OBD ECU.

6.1.16.4 Fail criteria2 (if supported):

a. Fail if any responses differ from global responses.

a. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.1.17 DM6: Emission related pending DTCs

6.1.17.1 Actions:

a. Global DM6 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 3038, 1706)).

6.1.17.2 Fail criteria:

a. Fail if any ECU reports pending DTCs

b. Fail if any ECU does not report MIL off.

c. Fail if no OBD ECU provides DM6.

[20] Section A.8 illustrates the allowed values for the On, Off, and flashing states of the MIL, according to table 5 of SAE J1939-73. The short MI state is not allowed, and the flashing states are not demonstrated in test procedures.

6.1.17.3 Actions2:

a. DS DM6 to each OBD ECU.

6.1.17.4 Fail criteria2:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.1.18 DM12: Emissions related active DTCs

6.1.18.1 Actions:

a. Global DM12 (send Request (PGN 59904) for PGN 65236 (SPNs 1213-1215, 1706, and 3038)).

6.1.18.2 Fail criteria:

a. Fail if any ECU reports active DTCs.

b. Fail if any ECU does not report MIL off.

c. Fail if no OBD ECU provides DM12.

6.1.18.3 Actions2:

a. DS DM12 to all OBD ECUs.

6.1.18.4 Fail criteria2:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.1.19 DM23: Emission Related Previously Active DTCs

6.1.19.1 Actions:

a. Global DM23 (send Request (PGN 59904) for PGN 64949 (SPNs 1213-1215, 3038, 1706)).

6.1.19.2 Fail criteria:

a. Fail if any ECU reports previously active DTCs.

b. Fail if any ECU does not report MIL off. See section A.8 for allowed values.

c. Fail if no OBD ECU provides DM23.

6.1.19.3 Actions2:

a. DS DM23 to each OBD ECU.

6.1.19.4 Fail criteria2:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.1.20 DM28: Permanent DTCs

6.1.20.1 Actions:

a. Global DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 3038, 1706)).

6.1.20.2 Fail criteria:

a. Fail if any ECU reports a permanent DTC.

b. Fail if any ECU does not report MIL off.

c. Fail if no OBD ECU provides DM28.

6.1.20.3 Actions2:

a. DS DM28 to each OBD ECU.

6.1.20.4 Fail criteria2:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.1.21 DM27: All Pending DTCs

6.1.21.1 Actions:

a. Global DM27 (send Request (PGN 59904) for PGN 64898 (SPNs 1213-1215, 3038, 1706)).

6.1.21.2 Fail criteria: (if supported)

a. Fail if any OBD ECU reports an all pending DTC.

b. Fail if any ECU does not report MIL off.

6.1.21.3 Actions2:

a. DS DM27 to each OBD ECU.

6.1.21.4 Fail criteria2:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.1.22 DM29: Regulated DTC counts

6.1.22.1 Actions:

a. Global DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)).

6.1.22.2 Fail criteria:

a. For ECUs that support DM27, fail if any ECU does not report pending/all pending/MIL on/previous MIL on/permanent = 0/0/0/0/0.[21]

b. For ECUs that do not support DM27, fail if any ECU does not report pending/all pending/MIL on/previous MIL on/permanent = 0/0xFF/0/0/0.

c. For non-OBD ECUs, fail if any ECU reports pending, MIL-on, previously MIL-on or permanent DTC count greater than 0

d. Fail if no OBD ECU provides DM29.

6.1.22.3 Actions:

a. DS DM29 to each OBD ECU.

6.1.22.4 Fail criteria:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.1.23 DM31: DTC to Lamp Association

6.1.23.1 Actions:

a. Global DM31 (send Request (PGN 59904) for PGN 41728 (SPNs 1214-1215, 4113, 4117)).

6.1.23.2 Fail criteria (if supported):

a. Fail if any received ECU response does not report MIL off.

6.1.24 DM25: Expanded freeze frame

6.1.24.1 Actions:

a. DS DM25 (send Request (PGN 59904) for PGN 64951 (SPNs 3300, 1214-1215)) to each OBD ECU that responded to DS DM24 with supported freeze frame SPNs.

6.1.24.2 Fail criteria:

a. Fail if any OBD ECU provides freeze frame data other than no freeze frame data stored [i.e., bytes 1-5= 0x00 and bytes 6-8 = 0xFF].

6.1.25 DM20: Monitor performance ratio

6.1.25.1 Actions:

a. DS DM20 (send Request (PGN 59904) for PGN 49664 (SPNs 3048-3049, 3066-3068)) to each OBD ECU.

    i. Store ignition cycle counter value (SPN 3048) for later use.

[21] The count of number of fault codes for 'all pending' DTCs corresponds to the number of pending fault DTCs reported by DM27. If DM27 is not supported by an ECU, all DM29 responses from that ECU should report 0xFF for the number of all pending DTCs (SPN 4105). A fail shall be noted for an ECU that does not support DM27, but does report something other than 0xFF for SPN 4105 in a DM29 response.

6.1.25.2 Fail criteria:

a. Fail if any difference compared to data received during global request earlier in test 1.8.

b. Fail if NACK not received from OBD ECUs that did not respond to global query in test 1.8.

6.1.26 Data stream support verification

6.1.26.1 Actions:

a. Gather broadcast data for all DM24 supported datastream.

b. Gather/timestamp each parameter at least three times to be able to verify frequency of broadcast.

6.1.26.2 Fail/warn criteria:

a. Fail if no response/no valid data for any broadcast SPN indicated as supported in DM24.

b. Fail if any parameter is not broadcast within ± 10% of the specified broadcast period.[22]

c. Fail/warn if any broadcast data is not valid for KOEO conditions as per section A.1, Minimum Data Stream Support.

6.1.26.3 Actions2:

a. DS messages to ECU that indicated support in DM24 for upon request SPNs and SPNs not observed in step 1.

b. If no response/no valid data for any SPN requested in 6.1.25.3.a, send global message to request that SPN(s).

6.1.26.4 Fail/warn criteria2:

a. Fail if no response/no valid data for any upon request SPN indicated as supported in DM24.

b. Fail/warn if any upon request data is not valid for KOEO conditions as per section A.1.

c. Warn if an expected SPN from the DM24 support list is provided by a non-OBD ECU.

d. Warn when global request was required for “broadcast” SPN.

6.1.27 Part 1 to Part 2 Transition

6.1.27.1 Actions:

a. Testing may be stopped for vehicles with failed tests and for vehicles with the MIL on or a non-emissions related fault displayed in DM1. Vehicles with the MIL on will fail subsequent tests.

[22] There are potential exceptions to scheduled broadcasts that are allowed implementations.
(a) Data may be available on request only for a given network segment.
(b) SAE J1939-71 allows sampling of control messages to be provided on a given network segment, where the data is not needed for control purposes.
(c) Several engine messages are engine speed dependent and are not broadcast on a fixed period.
(d) The need to send multiple BAM messages in a single second can disrupt timing by more than 10%.
These exceptions may not be automated in initial data analyses provided by the test tool.

b. The transition from part 1 to part 2 shall be as provided below.

   i. The engine shall be started without turning the key off.

   ii. Or, an electric drive or hybrid drive system shall be placed in the operating mode used to provide power to the drive system without moving the vehicle, if not automatically provided during the initial key off to key on operation.

   iii. The engine shall be allowed to idle one minute.

6.2 Part 2 Key On Engine Running Data Collection

Part 2 Purpose: Verify data in Key-on, engine running (KOER) operation with no implanted faults.

6.2.1 Verify engine running

6.2.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.2.1.2 Warn criteria:

a. If engine speed is < 400 rpm, prompt/warn operator to confirm engine is running and then press enter.

6.2.2 DM5: Diagnostic readiness 1

6.2.2.1 Actions:

a. Global DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1218-1223)).

b. Display monitor readiness composite value in log for OBD ECU replies only.

6.2.2.2 Fail/warn criteria:

a. Fail/warn per the section A.6 Criteria for Readiness 1 Evaluation.[23]

b. Fail if any OBD ECU reports active/previously active fault DTC count not = 0/0.

c. Warn if any individual required monitor, except Continuous Component Monitoring (CCM) is supported by more than one OBD ECU.

6.2.2.3 Actions2:

a. DS DM5 to each OBD ECU.

6.2.2.4 Fail criteria2:

a. Fail if any difference compared to data received during global request.

[23] Engine operation (even for 1 minute) before this data is collected can result in completed monitors, especially those that are intended to be continuous. Thus, monitor transitions from incomplete to complete must be allowed with the engine running. Section A.6 discusses the resulting engine running evaluation further.

6.2.3 DM24: SPN support

6.2.3.1 Actions:

a. DS DM24 (send Request (PGN 59904) for PGN 64950 (SPNs 3297, 4100-4103)) to each OBD ECU.

6.2.3.2 Fail criteria:

a. Fail if the message data received differs from that provided in part 1.[24]

6.2.4 DM20: Monitor performance ratio

6.2.4.1 Actions:

a. Global DM20 (send Request (PGN 59904) for PGN 49664 (SPNs 3048-3049, 3066-3068)).

6.2.4.2 Fail criteria:

a. Fail if any ECU reports different SPNs as supported for data than in part 1.

b. Fail if any denominator does not match denominator recorded in part 1.

c. Fail if any ECU does not report a value for ignition cycle that is one cycle greater than the value reported by that ECU in part 1.

6.2.4.3 Actions2:

a. DS DM20 to ECUs that responded to global DM20 in part 1.

6.2.4.4 Fail criteria2:

a. Fail if any difference compared to data received during global request in 6.2.4.1.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.2.5 DM19: Calibration information

6.2.5.1 Actions:

a. DS DM19 (send Request (PGN 59904) for PGN 54016 (SPNs 1634-1635)) to all ECUs that responded to global DM19 in part 1.

6.2.5.2 Fail criteria:

a. Fail if any ECU reports a different number of CAL ID and CVNs or different CAL ID and CVN values than was provided by the ECU in part 1.[25]

6.2.6 DM56: Model year and certification engine family

6.2.6.1 Actions:

a. DS DM56 (send Request (PGN 59904) for PGN 64711 (SPNs 5844 and 5845)) to each OBD ECU.

[24] This can be accomplished with a comparison to the responses received in part 1. The order of SPNs must remain constant as DM24 defines a fixed format record layout for the freeze frame content in DM25.
[25] This can be accomplished through a simple comparison. It is not necessary to attempt to account for a different ordering among CAL IDs and CVNs displayed as the regulation presumes the order will remain constant. (Most Important CAL ID must be first).

6.2.6.2 Fail criteria (if supported):

a. Fail if any difference is found when compared to data received during part 1.

6.2.7 Component ID: Make, Model, Serial Number Support

6.2.7.1 Actions:

a. Destination Specific (DS) Component ID request (PGN 59904) for PGN 65259 (SPNs 586, 587, and 588) to each OBD ECU.

6.2.7.2 Fail criteria:

a. Fail if any device does not support PGN 65259 with the engine running that supported PGN 65259 with the engine off in part 1.

b. Fail if there is any difference between the part 2 response and the part 1 response, as PGN 65259 data is defined to be static values.

6.2.7.3 Actions2:

a. Global Request for Component ID request (PGN 59904) for PGN 65259 (SPNs 586, 587, and 588)

b. Display each positive return in the log.

6.2.7.4 Fail criteria2 for function 0:

a. Fail if there is no positive response from function 0. (Global request not supported or timed out).

b. Fail if the global response does not match the destination specific response from function 0.

6.2.7.5 Warn criteria2 for OBD ECUs other than function 0:

a. Warn if Component ID not supported for the global query in 6.2.7.3 with engine running.

6.2.8 DM26: Diagnostic readiness 3

6.2.8.1 Actions:

a. DS DM26 (send Request (PGN 59904) for PGN 64952 (SPNs 3301-3305)) to each OBD ECU.

   i. Record time since engine start (SPN 3301) from each ECU and timestamp of when message was received.

b. Display monitor readiness composite value in log for OBD ECU replies only.

6.2.8.2 Fail criteria:

a. Fail if any difference in any ECU regarding readiness status this cycle compared to responses in part 1 after DM11.

b. Fail if any ECU reports number of warm-ups SCC (SPN 3302) greater than zero.[26]

c. Fail if NACK not received from OBD ECUs that did not provide a DM26 response.

[26] 13 CCR 1971.1 (c) (c. 2013) defines a warm-up cycle to require a 40 degree F temperature rise in the engine coolant temperature. That is unlikely to occur in the time expected. Therefore, zero is the correct response.

6.2.8.3 Warn criteria:

a. Warn if any individual required monitor, except Continuous Component Monitoring (CCM) is supported by more than one OBD ECU.

6.2.8.4 Actions2:

a. Global DM26.

b. Record time since engine start (SPN 3301) from each ECU and timestamp of when message was received.

6.2.8.5 Fail criteria2:

a. Fail if any difference compared to data received from DS request when taking into account additional time elapsed by differences in timestamps of responses received from DS requests and global request [by ECU].

   i.e., T2 – T1 <= SPN 3301 response data value <= T2 – T1 + 1 s.

6.2.9 DM21: Diagnostic readiness 2

6.2.9.1 Actions:

a. Global DM21 (send Request (PGN 59904) for PGN 49408 (SPNs 3069, 3294-3296)).

6.2.9.2 Fail criteria:

a. Fail if any ECU reports > 0 distance SCC (SPN 3294).

b. Fail if no ECU reports time (SPN 3295) or distance (SPN 3069) with MIL on.

c. Fail if any ECU reports > 0 for time (if supported) or distance with MIL on.

d. Fail if any ECU reports zero time SCC (SPN 3296) (if supported).

e. Warn if no OBD ECU reports time (SPN 3296) for DM21.

6.2.9.3 Actions2:

a. DS DM21 to each OBD ECU.

6.2.9.4 Fail criteria2:

a. Fail if any difference compared to data received from global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.2.10 DM7/DM30: Command Non-continuously Monitored Test/Scaled Test Results

6.2.10.1 Actions:

a. DS DM7 to each OBD ECU with TID 247+ for each DM24 SPN +FMI 31 provided by OBD ECU's DM24 response.

6.2.10.2 Fail criteria:

a. Fail if there is any difference in each ECU's provided test result labels (SPN and FMI combinations) from the test results received in part 1 test 11, paragraph 6.1.11.

6.2.10.3 Warn criteria:

a. Warn if all test results show initialized results across all SPNs requested.[27]

6.2.11 DM27: All Pending DTCs

6.2.11.1 Actions:

a. Global DM27 (send Request (PGN 59904) for PGN 64898 (SPNs 1213-1215, 3038, 1706)).

6.2.11.2 Fail criteria: (if supported)

a. Fail if any OBD ECU that supported DM27 in step 6.1.20 fails to respond.

b. Fail if any OBD ECU reports an all pending DTC.

c. Fail if any ECU does not report MIL off.

6.2.11.3 Actions2:

a. DS DM27 to each OBD ECU that supported DM27.

6.2.11.4 Fail criteria2:

a. Fail if any difference compared to data received during global request.

6.2.12 DM29: Regulated DTC counts

6.2.12.1 Actions:

a. Global DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)).

6.2.12.2 Fail criteria:

a. For OBD ECUs that did support DM27 in step 6.2.10, fail if any ECU does not report pending/all pending/MIL on/previously MIL on/permanent = 0/0/0/0/0.

b. For OBD ECUs that did not support DM27 in step 6.2.10, fail if any ECU does not report pending/all pending/MIL on/previous MIL on/permanent = 0/0xFF/0/0/0.

c. For non-OBD ECUs, fail if any ECU reports any pending, MIL-on, previously MIL-on, or permanent DTC count that is greater than 0

d. Fail if no OBD ECU provides DM29.

6.2.12.3 Actions2:

a. DS DM29 to each OBD ECU.

[27] The same set of test results labels should be available for each SPN supported with the engine off as with the engine running. The running engine may cause some results to be complete, so it is inappropriate to assume that all tests will still be initialized following the DM11 clear faults command in part 1.

6.2.12.4 Fail criteria2:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query. [28]

6.2.13 DM31: DTC to Lamp Association

6.2.13.1 Actions:

a. DS DM31 (send Request (PGN 59904) for PGN 41728 (SPNs 1214-1215, 4113, 4117)) to each OBD ECU.

6.2.13.2 Fail criteria (if supported):

a. Fail if any ECU does not report MIL off. See section A.8 for allowed values.

b. Fail if NACK not received from OBD ECUs that did not provide DM31.

6.2.14 DM25: Expanded freeze frame

6.2.14.1 Actions:

a. DS DM25 (send Request (PGN 59904) for PGN 64951 (SPNs 3300, 1214-1215)) to each OBD ECU that responded to global DM24 with supported freeze frame SPNs in part 1.

6.2.14.2 Fail criteria:

a. Fail if any OBD ECU provides freeze frame data other than bytes 1-5= 0x00 and bytes 6-8 = 0xFF (No freeze frame data available).

6.2.15 DM33: Emission increasing auxiliary emission control device active time

6.2.15.1 Actions:

a. Global DM33 (send Request (PGN 59904) for PGN 41216 (SPNs 4124-4126)).

b. Create list of reported EI-AECD timers by ECU.

6.2.15.2 Fail criteria:

a. Fail if no ECU responds.

6.2.15.3 Warn criteria:

a. Warn if only response(s) = 0xFB (no EI-AECDs) for EI-AECD number (byte 1).

6.2.15.4 Actions2:

a. DS DM33 to each OBD ECU.

[28] An ECU that does not support a given PGN will not respond to a global request and shall NACK destination specific requests, as described in SAE J1939-21. These responses are equivalent; both deny the availability of the requested data from the ECU. Additional comments regarding SAE J1939-21 precede part 1 step 1.

6.2.15.5 Fail criteria2:

a. Fail if any difference is detected when response data is compared to data received from global request, which is greater than 2 minutes more than the times reported from the responses received from the global request in 6.2.15.2.[29]

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.2.16 DM34: NTE status

6.2.16.1 Actions:

a. Global DM34 (send Request (PGN 59904) for PGN 40960 (SPNs 4127-4132)).

6.2.16.2 Fail criteria:

a. Fail if no ECU responds.

b. Fail if any ECU response is not = 0b00 (Outside Control Area) for NOx and PM control areas (byte 1 bits 7-8, byte 2 bits 7-8).

c. Fail if any ECU response is not = 0b00 (Outside Area) or 0b11 (not available) for NOx/PM carve-out/deficiency areas (byte 1 bits 5-6 and byte 2 bits 5-6).

d. Fail if any ECU response is not = 0b11 for byte 1 bits 1-2) and byte 2 bits 1-2).

e. Fail if any reserved bytes 3-8 are not = 0xFF.

6.2.16.3 Actions:

a. DS DM34 to each OBD ECU which responded to the DM34 global request in step 1.

6.2.16.4 Fail criteria:

a. Fail if any difference compared to data received from global request.

b. Fail if NACK received from OBD ECUs that responded to the global query in part 1.

6.2.17 KOER Datastream verification

6.2.17.1 Actions:

a. Gather broadcast data for all DM24 supported datastream SPNs.

6.2.17.2 Fail criteria:

a. Fail if no response/no valid data for any broadcast SPN indicated as supported in DM24.

b. Fail/warn if any broadcast data is not valid for KOER conditions as per section A.1,_Minimum Data Stream Support.

6.2.17.3 Actions2:

a. DS messages to ECU that indicated support in DM24 for upon request SPNs and SPNs not observed in step 1.

b. If no response/no valid data for any SPN requested in 6.2.16.3.a, send global message to request that SPN(s).

[29] A Monte-Carlo effect in response times due to the time required to receive the TP.BAM responses compared to the time the destination specific query is sent and received can create a false positive indication for this test step, because the engine is running during part 2. It is unlikely that such differences should ever exceed 2 minutes.

6.2.17.4 Fail/warn criteria2:

a. Fail if no response/no valid data for any upon request SPN indicated as supported in DM24.

b. Fail/warn if any upon request data is not valid for KOER conditions as per section A.1.

c. Warn when global request was required for “broadcast” SPN.

6.2.18 Part 2 to Part 3 transition

6.2.18.1 Actions:

a. Turn Engine Off and keep the ignition key in the off position.

b. Implant Fault A according to engine manufacturer’s instruction. (See section 5 for additional discussion).

c. Turn ignition key to the ON position.

d. Observe MIL and Wait to Start Lamps in Instrument Cluster

e. Start Engine after MIL and Wait to Start Lamp (if equipped) have extinguished.

6.3 Part 3 Test Pending Fault A

Part 3 Purpose: Implant the two trip fault identified as Fault A by the engine manufacturer and then start the engine immediately. Fault A should be implanted with the ignition key in the off position to minimize the amount of time that would be available for a circuit continuity fault to be detected before the engine is started[30]. The OBD system will set a pending fault during the first operating cycle in part 3. Verify pending fault and other data in KOER. Part 4 verifies the MIL-On, Confirmed Fault in DM12.

6.3.1 Confirm engine running status

6.3.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.3.1.2 Warn criteria:

a. If engine speed is < 400 rpm, prompt/warn operator to confirm engine is running and then press enter.

6.3.2 DM6: Emission related pending DTCs

6.3.2.1 Actions:

a. Global DM6 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 3038, 1706)).

   i. Repeat request for DM6 no more frequently than once per s until one or more ECUs reports a pending DTC.

   ii. Time-out after every 5 minutes and ask user ‘yes/no’ to continue if still no pending DTC; and fail if user says 'no' and no ECU reports a pending DTC.

[30] To best serve this part, the implanted fault should run multiple times per drive cycle and must run at idle. Ideally this fault will not be detected as a pending fault between the time the ignition key is transitioned from off to on and the engine begins to crank. Subsequent tests/steps and the associated pass/fail/warn criteria rely upon on the implanted fault taking two trips to mature from pending to confirmed and for the fault to be detected/matured within 5 minutes solely with engine idle operation (no vehicle movement/driving).

6.3.2.2 Fail Criteria:

a. Fail if no OBD ECU supports DM6.

6.3.2.3 Warn criteria:

a. Warn if any ECU reports > 1 pending DTC

b. Warn if more than one ECU reports a pending DTC.

6.3.2.4 Actions2:

a. DS DM6 to each OBD ECU.

6.3.2.5 Fail criteria2:

a. Fail if any difference compared to data received with global request.

b. Fail if all [OBD] ECUs do not report MIL off. See section A.8 for allowed values.

c. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.3.3 DM27: All pending DTCs

6.3.3.1 Actions:

a. Global DM27 (send Request (PGN 59904) for PGN 64898 (SPNs 1213-1215, 3038, 1706)).

6.3.3.2 Fail criteria (if supported):

a. Fail if no ECU reports the same DTC observed in step 6.3 in a positive DM27 response.

6.3.3.3 Warn criteria (if supported):

a. Warn if any ECU additional DTCs are provided than the DTC observed in step 6.3 in a positive DM27 response.

6.3.3.4 Actions2:

a. DS DM27 to each OBD ECU.

6.3.3.5 Fail criteria2 (if supported):

a. Fail if any difference compared to data received with global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.3.4 DM29: Regulated DTC counts

6.3.4.1 Actions:

a. Global DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)).

6.3.4.2 Fail criteria:

a. Fail if any ECU reports > 0 for MIL on, previous MIL on, or permanent fault counts.

b. Fail if no ECU reports > 0 emission-related pending (SPN 4104).

c. Fail if any ECU reports a different number of emission-related pending DTCs than what that ECU reported in DM6 earlier in this part.

d. For OBD ECUs that support DM27, fail if any ECU reports a lower number of all pending DTCs (SPN 4105) than the number of emission-related pending DTCs.

e. For OBD ECUs that support DM27, fail if any ECU reports a lower number of all pending DTCs than what that ECU reported in DM27 earlier in this part.

f. For OBD ECUs that do not support DM27, fail if any ECU does not report number of all pending DTCs = 0xFF.

g. For non-OBD ECUs, fail if any ECU reports pending, MIL-on, previously MIL-on or permanent DTC count greater than 0.

6.3.4.3 Warn criteria:

a. Warn if any ECU reports > 1 for pending or all pending.

b. Warn if more than one ECU reports > 0 for pending or all pending.

6.3.5 DM31: DTC to lamp association

6.3.5.1 Actions:

a. DS DM31 (send Request (PGN 59904) for PGN 41728 (SPNs 1214-1215, 4113, 4117)) to ECU with DM6 pending DTC.

6.3.5.2 Fail criteria (if supported):

a. Fail if MIL not reported as off in all returned DTCs. See section A.8 for allowed values.

b. Fail if NACK not received from OBD ECUs that did not provided a DM31 message

6.3.6 DM1: Active diagnostic trouble codes (DTCs)

6.3.6.1 Actions:

a. Receive DM1 broadcast info (PGN 65226 (SPNs 1213-1215, 1706, and 3038)).

6.3.6.2 Fail criteria:

a. Fail if no OBD ECU supports DM1.

b. Fail if any OBD ECU reports an active DTC.

c. Fail if any OBD ECU does not report MIL off. See section A.8 for allowed values.

d. Fail if any non-OBD ECU does not report MIL off or not supported.

6.3.7 DM2: Previously active diagnostic trouble codes (DTCs)

6.3.7.1 Actions:

a. Global DM2 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 1706, and 3038)).

6.3.7.2 Fail criteria (for any ECU that responds if supported):

a. Fail if any OBD ECU reports a previously active DTC.

b. Fail if any OBD ECU does not report MIL off.

c. Fail if any non-OBD ECU does not report MIL off or not supported.

6.3.7.3 Actions2:

a. DS DM2 to each OBD ECU.

6.3.7.4 Fail criteria2:

a. Fail if any difference compared to data received from global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.3.8 DM5: Diagnostic readiness 1

6.3.8.1 Actions:

a. Global DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1218-1219)).

6.3.8.2 Fail criteria:

a. Fail if any OBD ECU does not report 0/0 for the number of active and the number of previously active DTCs.

6.3.9 DM12: Emissions related active DTCs

6.3.9.1 Actions:

a. Global DM12 (send Request (PGN 59904) for PGN 65236 (SPNs 1213-1215, 1706, and 3038)).

6.3.9.2 Fail criteria:

a. Fail if any ECU reports an active DTC.

b. Fail if any OBD ECU does not report MIL off. See section A.8 for allowed values

c. Fail if any non-OBD ECU does not report MIL off or not supported.

d. Fail if no OBD ECU provides DM12

6.3.9.3 Actions2:

a. DS DM12 to each OBD ECU.

6.3.9.4 Fail criteria2:

a. Fail if any difference compared to data received from global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.3.9.5 DM23: Emission related previously active DTCs

6.3.9.6 Actions:

a. Global DM23 (send Request (PGN 59904) for PGN 64949 (SPNs 1213-1215, 3038, 1706)).

6.3.9.7 Fail criteria:

a. Fail if any ECU reports a previously active DTC.

b. Fail if any OBD ECU does not report MIL off.

c. Fail if any non- OBD ECU does not report MIL off or not supported.

d. Fail if no OBD ECU provides DM23

6.3.9.8 Actions2:

a. DS DM23 to each OBD ECU.

6.3.9.9 Fail criteria2:

a. Fail if any difference compared to data received from global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.3.10 DM28: permanent DTCs

6.3.10.1 Actions:

a. Global DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 3038, 1706)).

6.3.10.2 Fail criteria:

a. Fail if any ECU reports a permanent DTC.

b. Fail if any OBD ECU does not report MIL off.

c. Fail if any non-OBD ECU does not report MIL off or not supported.

d. Fail if no OBD ECU provides DM28

6.3.10.3 Actions2:

a. DS DM28 to each OBD ECU.

6.3.10.4 Fail criteria2:

a. Fail if any difference compared to data received from global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.3.11 DM24: SPNs Supported

6.3.11.1 Actions:

a. DS DM24 (send Request (PGN 59904) for PGN 64950 (SPNs 3297, 4100-4103)) to each OBD ECU.

b. Compare response with responses received in part 1 test 4 for each OBD ECU.

6.3.11.2 Fail criteria:

a. Fail if the message data received differs from that provided in part 1.

b. Fail if NACK not received from OBD ECUs that did not provide DM24.

6.3.11.3 DM25: Expanded freeze frame

6.3.11.4 Actions:

a. DS DM25 (send Request (PGN 59904) for PGN 64951 (SPNs 3300, 1214-1215)) to each OBD ECU.

b. Translate and print in log file all received freeze frame data with data labels assuming data received in order expected by DM24 response for visual check by test log reviewer.

6.3.11.5 Fail/warn criteria:

a. Fail if no ECU has freeze frame data to report.

b. Fail if received data does not match expected number of bytes based on DM24 supported SPN list for that ECU.

c. Fail if freeze frame data does not include the same SPN+FMI as DM6 pending DTC earlier in this part.[31]

d. Fail/warn per section A.2, Criteria for Freeze Frame Evaluation.

e. Warn if more than 1 freeze frame data set is included in the response.

f. Fail if NACK not received from OBD ECUs that did not provide DM25 response to query.

6.3.12 DM20: Monitor performance ratio

6.3.12.1 Actions:

a. DS DM20 (send Request (PGN 59904) for PGN 49664 (SPNs 3048)) to ECU(s) that responded in part 1 with DM20 data.

b. Store ignition cycle counter value (SPN 3048).

6.3.13 DM21: Diagnostic readiness 2

6.3.13.1 Actions:

a. DS DM21 (send Request (PGN 59904) for PGN 49408 (SPNs 3069, 3295)) to each OBD ECU.

[31] Where initial conditions were not well observed, there may be more than one DTC in the FF data. The DM6 identified DTC is required to be included a stored list of freeze frame entries.

6.3.13.2 Fail criteria:

a. Fail if any ECU reports distance (SPN 3069) or time (SPN 3295) with MIL on > 0.

b. Fail if NACK not received from OBD ECUs that did not provide DM21 response to DS query.

6.3.14 Part 3 to Part 4 Transition - Complete Fault A First Trip

6.3.14.1 Actions:

a. Turn the engine off.

b. Confirm Fault A is still implanted according to the manufacturer's instruction.

c. Wait manufacturer's recommended interval with the key in the off position.

d. Turn ignition key to the ON position.

e. Observe MIL and Wait to Start Lamp in Instrument Cluster

f. Start Engine after MIL and Wait to Start Lamp (if equipped) have extinguished.

f. Wait as indicated by the engine manufacturer's recommendations for Fault A.

6.4 Part 4 Test Confirmed Fault A

Part 4 Purpose: Mature Fault A to MIL on/active. Verify MIL on/active fault and other data in KOER responses.

6.4.1 Confirm engine running status

6.4.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.4.1.2 Warn criteria:

a. If engine speed is < 400 rpm, prompt/warn operator to confirm engine is running and then press enter.

6.4.2 DM12: Emissions related active DTCs

6.4.2.1 Actions:

a. Global DM12 (send Request (PGN 59904) for PGN 65236 (SPNs 1213-1215, 1706 and 3038)) to retrieve confirmed and active DTCs.

   i. Repeat request no more frequently than once per s until one or more ECUs reports a confirmed and active DTC.

   ii. Time-out after every 5 minutes and ask user 'yes/no' to continue if there is still no confirmed and active DTC; fail if user says 'no' and no ECU reports a confirmed and active DTC.

6.4.2.2 Fail criteria:

a. Fail if no ECU reports MIL on. See section A.8 for allowed values.

b. Fail if DM12 DTC(s) is (are) not the same SPN+FMI(s) as DM6 pending DTC in part 3.

6.4.2.3 Warn criteria:

a. Warn if any ECU reports > 1 confirmed and active DTC.

b. Warn if more than one ECU reports a confirmed and active DTC.

6.4.2.4 Actions2:

a. DS DM12 to each OBD ECU.

6.4.2.5 Fail criteria2:

a. Fail if any difference compared to data received from global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.4.3 DM1: Active diagnostic trouble codes (DTCs)

6.4.3.1 Actions:

a. Receive broadcast data (PGN 65226 (SPNs 1213-1215, 3038, 1706)).

6.4.3.2 Fail criteria:

a. Fail if no ECU reports an active DTC and MIL on

b. Fail if any OBD ECU report does not include its DM12 DTCs in the list of active DTCs

c. Fail if any OBD ECU reports fewer active DTCs in its DM1 response than its DM12 response.

d. Warn if any non-OBD ECU reports an Active DTC.

e. Warn if more than 1 active DTC is reported by the vehicle.

6.4.4 DM2: Previously active diagnostic trouble codes (DTCs)

6.4.4.1 Actions:

a. Global DM2 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 1706, and 3038)).

6.4.4.2 Fail criteria (if supported):

a. Fail if any OBD ECU reports > 0 previously active DTCs.

b. Fail if any OBD ECU reports a different MIL status (e.g., on and flashing, or off) than it did in DM12 response earlier in this part.

6.4.4.3 Actions:

a. DS DM2 to each OBD ECU.

6.4.4.4 Fail criteria (if supported):

a. Fail if any difference compared to data received from global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.4.5 DM23: Emission related previously active DTCs

6.4.5.1 Actions:

a. DS DM23 (send Request (PGN 59904) for PGN 64949 (SPNs 1213-1215, 1706, and 3038)) to each OBD ECU.

6.4.5.2 Fail criteria:

a. Fail if any ECU reports > 0 previously active DTC.

b. Fail if any ECU reports a different MIL status than it did in DM12 response earlier in this part.

c. Fail if NACK not received from OBD ECUs that did not provide DM23 response.

d. Fail if no OBD ECU provides DM23.

6.4.6 DM5: Diagnostic readiness 1

6.4.6.1 Actions:

a. Global DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1218-1219)).

6.4.6.2 Fail criteria:

a. Fail if no OBD ECU reports number of active DTCs as > 0.

b. Fail if any OBD ECU reports a different number of active DTCs than it did in DM1 response earlier in this part.

c. Fail if any OBD ECU reports > 0 previously active DTCs.

6.4.7 DM31: DTC to lamp association

6.4.7.1 Actions:

a. DS DM31 (send Request (PGN 59904) for PGN 47128 (SPNs 1214-1215, 4113, 4117)) to each ECU supporting DM12.

6.4.7.2 Fail criteria (if supported):

a. Fail if an OBD ECU does not include the same SPN and FMI from its DM12 response earlier in this part and report MIL on Status for that SPN and FMI in its DM31 response (if DM31 is supported).

b. Fail if NACK not received from OBD ECU that did not provide DM31 response.

6.4.8 DM6: Emission related pending DTCs

6.4.8.1 Actions:

a. Global DM6 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 1706, and 3038)).

6.4.8.2 Fail criteria:

a. Fail if any ECU reports a pending DTC.

b. Fail if any ECU reports a different MIL status than it did for DM12 response earlier in this part.

c. Fail if no OBD ECU provides a DM6 response.

6.4.8.3 Actions:

a. DS DM6 to each OBD ECU.

6.4.8.4 Fail criteria:

a. Fail if any difference compared to data received from global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.4.9 DM27: All pending DTCs

6.4.9.1 Actions:

a. Global DM27 (send Request (PGN 59904) for PGN 64898 (SPNs 1213-1215, 3038, 1706)).

6.4.9.2 Fail criteria (if supported):

a. Fail if any ECU reports a pending DTC.

b. Fail if any [OBD] ECU reports a different MIL status than it did for DM12 response earlier in this part.

6.4.9.3 Actions2:

a. DS DM27 to each OBD ECU.

6.4.9.4 Fail criteria (if supported):

a. Fail if any difference compared to data received from global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.4.10 DM25: Expanded freeze frame

6.4.10.1 Actions:

a. DS DM25 (send Request (PGN 59904) for PGN 64951 (SPNs 3300, 1214-1215)) to each OBD ECU.

6.4.10.2 Fail criteria:

a. Fail if no ECU reports freeze frame data.
b. Fail if DTC in freeze frame data does not include the DTC reported in DM12 earlier in this part.
c. Fail if NACK not received from OBD ECUs that did not provide DM25 response.

6.4.11 DM20: Monitor performance ratio

6.4.11.1 Actions:

a. DS DM20 (send Request (PGN 59904) for PGN 49664 (SPN 3048)) to ECU(s) that responded in part 1 with DM20 data.

6.4.11.2 Fail criteria:

a. Fail if ignition cycle counter (SPN 3048) for any ECU has not incremented by 1 compared to value recorded at end of part 3.

6.4.12 DM7/DM30: Command Non-continuously Monitored Test/Scaled Test Results

6.4.12.1 Actions:

a. DS DM7 to each OBD ECU that provided test results in part 1 using TID 246, SPN 5846, and FMI 31.

   i. (If TID 246 method not supported, use DS DM7 with TID 247 + each DM24 SPN+ FMI 31).

b. Create list of any ECU address+SPN+FMI combination with non-initialized test results.

6.4.12.2 Fail criteria:

a. Fail if there is any difference in each ECU's provided test result labels (SPN and FMI combinations) from the test results received in part 1 test 11, paragraph 6.1.11.

6.4.13 DM3: Diagnostic data clear/reset for previously active DTCs

6.4.13.1 Actions:

a. DS DM3 (send Request (PGN 59904) for PGN 65228) to each OBD ECU. [32]

b. Wait 5 seconds before checking for erased information.

6.4.13.2 Fail criteria (if supported):

a. Fail if any OBD ECU does not NACK with control byte = 1 or 2 or 3, or if any ECU erases any diagnostic information. See section A.5 for more information.

b. Warn if any OBD ECU NACKs with control byte = 3.

6.4.13.3 Actions2:

a. Global DM3.

b. Wait 5 seconds before checking for erased information.

6.4.13.4 Fail criteria2 (if supported):

a. Fail if any OBD ECU erases OBD diagnostic information.

6.4.14 DM7/DM30: Command Non-continuously Monitored Test/Scaled Test Results

6.4.14.1 Actions:

a. DS DM7 with TID 250 and each specific SPN+FMI that had non-initialized test results on list created in test 6.4.14.1.

6.4.14.2 Fail criteria:

a. Fail if any now reporting initialized values. Use this to help verify that no diagnostic information cleared with DM3 request.

[32] Implementations may overlap the DS DM3 requests here and in 6.7.16 to individual OBD ECUs and then combine the wait times into a single period.

6.4.15 Part 4 to Part 5 Transition -- complete fault A s trip

6.4.15.1 Actions:

a. Turn the engine off.

b. Wait engine manufacturer's recommended interval.

c. With the key in the off position remove the implanted fault A according to the manufacturer's instructions for restoring the system to a fault free operating condition.

d. Turn ignition key to the ON position.

e. Observe MIL in Instrument Cluster.

f. Start Engine after MIL and Wait to Start Lamp (if equipped) have extinguished.

g. Wait for manufacturer's recommended time for Fault A to be detected (as passed).

6.5 Part 5 Correct fault A first cycle

Part 5 Purpose: Remove fault. Run and pass diagnostic for 1st fault free driving cycle. Verify MIL on/active fault and other data in KOER.

6.5.1 Verify engine running

6.5.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.5.1.2 Warn criteria:

a. If after 5 s, engine speed is < 400 rpm, prompt/warn operator to confirm engine is running and then press enter.

6.5.2 DM12: Emission-related active DTCs

6.5.2.1 Actions:

a. Global DM12 (send Request (PGN 59904) for PGN 65236 (SPNs 1213-1215, 1706, and 3038)).

6.5.2.2 Fail criteria:

a. Fail if no OBD ECU reporting MIL on. See section A.8 for allowed values.

b. Fail if all OBD ECUs report no DM12 DTC set.

c. Fail if DM12 DTC reported does not match the DM6 DTC SPN and FMI reported from step 6.4.2.

d. Fail if any ECU reporting MIL as ON, flashing. See section A.8 for allowed values.

6.5.3 DM1: Active diagnostic trouble codes (DTCs)

6.5.3.1 Actions:

a. Receive DM1 broadcast data (PGN 65226 (SPNs 1213-1215, 1706, and 3038)).

6.5.3.2 Fail criteria:

a. For every [OBD] ECU that responded to the DM12 request in step 6.5.2.1, Fail if the DM1 response for the same ECU does not include the SPN(s) and associated FMI as given in the DM12 response.

b. For every [OBD] ECU that responded to the DM12 request in step 6.5.2.1, Fail if the DM1 response for the same ECU has a different MIL status than given in its DM12 response.

6.5.4 DM28: Permanent DTCs

6.5.4.1 Actions:

a. DS DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 3038, 1706)) to each OBD ECU.

6.5.4.2 Fail criteria:

a. Fail if no ECU reports a permanent DTC.

b. Fail if any ECU reports a different MIL status than it did for DM12 response earlier in this part.

c. Fail if permanent DTC does not match DM12 active DTC from earlier in this part.

d. Fail if NACK not received from OBD ECUs that did not provide a DM28 message.

6.5.5 DM29: Regulated DTC counts

6.5.5.1 Actions:

a. Global DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)).

6.5.5.2 Fail criteria:

a. Fail if any ECU reports > 0 for emission-related pending or previous MIL on.

b. Fail if no ECU reports > 0 MIL on DTCs where the same ECU provides one or more permanent DTCs.

c. Fail if any ECU reports a different number of MIL on DTCs than what that ECU reported in DM12 earlier in this part.

d. Fail if any ECU reports a different number of permanent DTCs than what that ECU reported in DM28 earlier in this part.

e. For OBD ECUs that support DM27,

   i. Fail if any ECU reports > 0; for all pending DTCs (SPN 4105)

   ii. Fail if any ECU reports 0xFF, for all pending DTCs.

f. For ECUs that do not support DM27,

   i. Fail if any ECU does not report number of all pending DTCs (SPN 4105) = 0xFF.

6.5.5.3 Warn criteria:

a. Warn if any ECU reports > 1 for MIL on or permanent.

b. Warn if more than one ECU reports > 0 for MIL on or permanent.

6.5.6 DM20: Monitor performance ratio

6.5.6.1 Actions:

a. DS DM20 (send Request (PGN 59904) for PGN 49664 (SPN 3048)) to OBD ECU(s) that provided DM20 data in part 1.

b. Store each ignition cycle counter value (SPN 3048) for future use.

6.5.7 Complete fault a three trip countdown cycle 1 and cycle 2.

6.5.7.1 Actions:

a. Turn the engine off to complete the 1st cycle.

b. Wait manufacturer's recommended interval with the key in the off position.

c. Start Engine for 2nd cycle.

d. Wait for manufacturer's recommended time for Fault A to be detected as passed.

e. Turn the engine off to complete the 2nd cycle.

f. Wait manufacturer's recommended interval with the key in the off position.

g. Start the engine for part 6.

h. Wait for manufacturer's recommended time for Fault A to be detected as passed.

6.6 Part 6 Complete fault A three cycle countdown

Part 6: Verify MIL on/active fault and other data in KOER during 3rd fault free "driving" cycle after the repair of Fault A.

6.6.1 Verify engine running

6.6.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.6.1.2 Fail criteria:

a. If after 5 s engine speed is < 400 rpm, prompt/warn operator to confirm engine is running and then press enter.

6.6.2 DM5: Diagnostic readiness 1

6.6.2.1 Actions:

a. Global DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1218-1219)).

6.6.2.2 Fail criteria:

a. Fail if no OBD ECU reports a count of > 0 active DTCs.

b. Fail if any OBD ECU reports > 0 previously active DTC.

6.6.2.3 Warn criteria:

a. Warn if any ECU reports a count of > 1 active DTC or previously active DTC.

6.6.3 DM12: Emissions related active DTCs

6.6.3.1 Actions:

a. DS DM12 (send Request (PGN 59904) for PGN 65236 (SPNs 1213-1215, 3038, 1706)) to each OBD ECU.

6.6.3.2 Fail criteria:

a. Fail if no [OBD] ECU reports an MIL-on active DTC.

b. Fail if no ECU reports MIL on. See Section A.8 for allowed values.

c. Fail if NACK not received from OBD ECUs that did not provide a DM12 message.

6.6.4 DM1: Active diagnostic trouble codes (DTCs)

6.6.4.1 Actions:

a. Receive broadcast DM1 (PGN 65226 (SPNs 1213-1215, 3038, 1706)).

6.6.4.2 Fail criteria:

a. Fail if no OBD ECU reports MIL on

b. Fail the DTC provided by the OBD ECU in DM12 is not included in its DM1 display.

c. Fail if any OBD ECU reports a different number of active DTCs than what that ECU reported in DM5 for number of active DTCs.

6.6.5 DM20: Monitor performance ratio

6.6.5.1 Actions:

a. DS DM20 (send Request (PGN 59904) for PGN 49664 (SPN 3048)) to OBD ECU(s) that responded in part 5 (test 6.5.4) with DM20 data.

6.6.5.2 Fail criteria:

a. Fail if any ignition cycle counter (SPN 3048) from same ECU as was stored in part 5 has incremented by a value other than 2.

6.6.6 DM23: Emission related previously active DTCs

6.6.6.1 Actions:

a. DS DM23 (send Request (PGN 59904) for PGN 64949 (SPNs 1213-1215, 3038, 1706)) to each OBD ECU.

6.6.6.2 Fail criteria:

a. Fail if any OBD ECU reports a previously active DTC.

b. Fail if no OBD ECU reports MIL on

c. Fail if NACK not received from OBD ECUs that did not provide a DM23 message.

6.6.7 DM28: Permanent DTCs

6.6.7.1 Actions:

a. DS DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 3038, 1706)) to each OBD ECU.

6.6.7.2 Fail criteria:

a. Fail if no ECU reports permanent DTC present.

b. Fail if permanent DTC provided does not match DM12 active DTC.

c. Fail if no ECU reports MIL on

d. Fail if NACK not received from OBD ECUs that did not provide a DM28 message.

6.6.8 DM29: Regulated DTC counts

6.6.8.1 Actions:

a. DS DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)) to each OBD ECU.

6.6.8.2 Fail criteria:

a. Fail if any ECU reports > 0 for emission-related pending or previous MIL on.

b. Fail if no ECU reports > 0 for MIL on.

c. Fail if any ECU reports a different number for MIL on than what that ECU reported in DM12.

d. Fail if no ECU reports > 0 for permanent.

e. Fail if any ECU reports a different number for permanent than what that ECU reported in DM28.

f. For ECUs that support DM27, fail if any ECU reports an all pending DTC (DM27) (SPN 4105) count that is less than its pending DTC (DM6) count.

g. For ECUs that do not support DM27, fail if any ECU does not report number of all pending DTCs = 0xFF

h. Fail if NACK not received from OBD ECUs that did not provide a DM29 message.

6.6.8.3 Warn criteria:

a. Warn if any ECU reports > 1 for MIL on.

b. Warn if more than one ECU reports > 0 for MIL on.

c. Warn if any ECU reports > 1 for permanent

d. Warn if more than one ECU reports > 0 for permanent.

6.6.9 DM31: DTC to lamp association

6.6.9.1 Actions:

a. DS DM31 (send Request (PGN 59904) for PGN 41728 (SPNs 1214-1215, 4113, 4117)) to ECU(s) reporting DM12 MIL on DTC active.

6.6.9.2 Fail criteria (if supported):

a. Fail if any ECU response does not report same DTC as its own DM12 response.

b. Fail if any ECU response does not report MIL on for its own DM12 DTC.

c. Fail if NACK not received from OBD ECUs that did not provide a DM31 message.

6.6.10 DM21: Diagnostic readiness 2

6.6.10.1 Actions:

a. DS DM21 (send Request (PGN 59904) for PGN 49408 (SPNs 3069, 3295)) to each OBD ECU.

6.6.10.2 Fail criteria:

a. Fail if any ECU reports distance with MIL on (SPN 3069) is > 0 or reports not supported.

b. Fail if any ECU reports time with MIL on greater than 0 minute, and did not report a DTC in its DM12 response.

c. Fail if no ECU supports DM21.

d. Fail if NACK not received from OBD ECUs that did not provide a DM21 message.

6.6.10.3 Warn criteria:

a. Warn if no ECU reports time with MIL on (SPN 3295) greater than 0 minute.

b. Warn if more than one ECU reports time with MIL on > 0 and difference between times reported is > 1 minute.

6.6.11 Complete fault A three trip countdown cycle 3

6.6.11.1 Actions:

a. Turn engine off

b. Wait engine manufacturer's recommended interval.

c. Turn key to on position.

d. If required by engine manufacturer, start the engine for start to start operating cycle effects.

e. Otherwise, Proceed with part 7.

f. Turn engine off.

g. Wait engine manufacturer's recommended interval.

h. Turn the key to the on position.

i. Proceed with part 7.

6.7 Part 7 Verify DM23 transition

Part 7 Purpose: Verify previous MIL on (DM23) fault and other data in KOEO, after completion of 3 fault free trips to extinguish MIL.

6.7.1 Verify engine off operation

6.7.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.7.1.2 Warn criteria:

a. If engine speed is > 0 rpm, prompt/warn operator to confirm engine is not running and then press enter.

6.7.2 DM23: Emission related previously active DTCs

6.7.2.1 Actions:

a. DS DM23 (send Request (PGN 59904) for PGN 64949 (SPNs 1213-1215, 1706, and 3038)) to each OBD ECU.

6.7.2.2 Fail criteria:

a. Fail if no OBD ECU reports previously active DTC.

b. Fail if reported previously active DTC does not match DM12 active DTC from part 6.

c. Fail if any ECU does not report MIL off and not flashing.

d. Fail if NACK not received from OBD ECUs that did not provide a DM23 message.

6.7.2.3 Warn criteria:

a. Warn if any ECU reports > 1 previously active DTC.

b. Warn if more than one ECU reports a previously active DTC.

6.7.3 DM2: Previously active diagnostic trouble codes (DTCs)

6.7.3.1 Actions:

a. Global DM2 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 1706, and 3038)).

6.7.3.2 Fail criteria (if supported):

a. Fail if no OBD ECU reports any previously active DTC(s).

b. Fail if any OBD ECU reports a fewer previously active DTCs than in DM23 response earlier in this part.

c. Fail if any OBD ECU fails to provide its DTC from its DM12 response in part 6 as a previously active DTC in its DM2 response.

d. Fail if any OBD ECU does not report MIL off. See Section A.8 for allowed values.

e. Fail if any non-OBD ECU does not report MIL off or not supported.

6.7.3.3 Actions2:

a. DS DM2 to each OBD ECU.

6.7.3.4 Fail criteria2 (if supported):

a. Fail if any difference compared to data received for global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.7.4 DM12: Emissions related active DTCs

6.7.4.1 Actions:

a. DS DM12 (send Request (PGN 59904) for PGN 65236 (SPNs 1213-1215, 1706, and 3038)) to each OBD ECU.

6.7.4.2 Fail criteria:

a. Fail if any OBD ECU reports an active DTC.

b. Fail if any OBD ECU does not report MIL off.

c. Fail if no OBD ECU supports DM12

d. Fail if NACK not received from OBD ECUs that did not provide a DM12 message.

6.7.5 DM1: Active diagnostic trouble codes (DTCs)

6.7.5.1 Actions:

a. Receive broadcast data (PGN 65226 (SPNs 1213-1215, 1706, and 3038)).

6.7.5.2 Fail criteria:

a. Fail if any OBD ECU reports an active DTC.

b. Fail if any OBD ECU does not report MIL off.

c. Fail if no OBD ECU provides DM1.

6.7.6 DM5: Diagnostic readiness 1

6.7.6.1 Actions:

a. Global DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1218-1219)).

6.7.6.2 Fail criteria:

a. Fail if any OBD ECU reports > 0 for active DTCs.

b. Fail if no ECU reports > 0 for previously active DTCs.

c. Fail if any OBD ECU reports a different number of previously active DTCs than in DM2 response earlier in this Part.

6.7.7 DM6: emission related pending DTCs

6.7.7.1 Actions:

a. Global DM6 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 1706, and 3038)).

6.7.7.2 Fail criteria:

a. Fail if any ECU reports a pending DTC.

b. Fail if any ECU does not report MIL off. See Section A.8 for allowed values.

6.7.7.3 Actions:

a. DS DM6 to each OBD ECU.

6.7.7.4 Fail criteria:

a. Fail if any difference compared to data received for global request from Step 6.7.7.1.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.7.8 DM27: All Pending DTCs

6.7.8.1 Actions:

a. Global DM27 (send Request (PGN 59904) for PGN 64898 (SPNs 1213-1215, 1706, and 3038)).

6.7.8.2 Fail criteria (if supported):

a. Fail if any OBD ECU reports a pending DTC.

b. Fail if any ECU does not report MIL off.

6.7.8.3 Actions:

a. DS DM27 to each OBD ECU.

6.7.8.4 Fail criteria (if supported):

a. Fail if any difference compared to data received for global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.7.9 DM28: Permanent DTCs

6.7.9.1 Actions:

a. DS DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 1706, and 3038)) to each OBD ECU.

6.7.9.2 Fail criteria:

a. Fail if any ECU reports a permanent DTC.

b. Fail if any ECU does not report MIL off.

c. Fail if NACK not received from OBD ECUs that did not provide DM28 message.

6.7.10 DM29: Regulated DTC counts

6.7.10.1 Actions:

a. Global DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)).

6.7.10.2 Fail criteria:

a. Fail if any ECU reports > 0 for pending, all pending, MIL on, or permanent.

b. Fail if no ECU reports > 0 previous MIL on.

c. Fail if any ECU reports a different number of previous MIL on DTCs than what that ECU reported in DM23 earlier in this part.

6.7.10.3 Warn criteria:

a. Warn if any ECU reports > 1 for previous MIL on.

b. Warn if more than one ECU reports > 0 for previous MIL on.

6.7.11 DM31: DTC to lamp association

6.7.11.1 Actions:

a. DS DM31 (send Request (PGN 59904) for PGN 41728 (SPNs 1214-1215, 4113, 4117)) to each OBD ECU.

6.7.11.2 Fail criteria (if supported):

a. Fail if any ECU response includes the same DTC as it reported by DM23 earlier in this part.

b. Fail if any ECU does not report MIL off for all DTCs reported.

c. Fail if NACK not received from OBD ECUs that did not provide DM31 message.

6.7.12 DM25: Expanded freeze frame

6.7.12.1 Actions:

a. DS DM25 (send Request (PGN 59904) for PGN 64951 (SPNs 3300, 1214-1215)) to each OBD ECU.

6.7.12.2 Fail criteria:

a. Fail if no ECU reports Freeze Frame data.

b. Fail if DTC in reported Freeze Frame data does not include the DTC provided by DM23 earlier in this part.

c. Fail if NACK not received from OBD ECUs that did not provide DM25 message.

6.7.12.3 Warn criteria:

a. Warn if more than one Freeze Frame is provided.

6.7.13 DM20: Monitor performance ratio

6.7.13.1 Actions:

a. DS DM20 (send Request (PGN 59904) for PGN 49664 (SPN 3048)) to ECU(s) that responded in part 5 with DM20 data.

6.7.13.2 Fail criteria:

a. Fail if ignition cycle counter (SPN 3048) for any ECU has incremented by other than 3 cycles from part 5.

6.7.14 DM21: Diagnostic readiness 2

6.7.14.1 Actions:

a. DS DM21 (send Request (PGN 59904) for PGN 49408 (SPN 3295)) to each OBD ECU.

6.7.14.2 Fail criteria:

a. Fail if no ECU reports time with MIL on (SPN 3295) greater than or equal to 1 minute.

b. Fail if NACK not received from OBD ECUs that did not provide DM21 message.

6.7.15 DM7/DM30: Command non-continuously monitored test/scaled test results

6.7.15.1 Actions:

a. DS DM7 with TID 246 + SPN 5846 +FMI 31.

    i. If TID 246 method not supported, use DS DM7 with TID 247 + each DM24 SPN+ FMI 31.

b. Create list of any ECU address+SPN+FMI combination with non-initialized test results.

6.7.15.2 Fail criteria:

a. Fail if any difference in the ECU address+SPN+FMI combinations that report test results compared to list created in part 1.

b. Fail if NACK received from OBD ECUs that did not support an SPN listed in its DM24 response.

6.7.16 DM3: Diagnostic data clear/reset for previously active DTCs

6.7.16.1 Actions:

a. Global DM3 (send Request (PGN 59904) for PGN 65228).

b. Wait 5 seconds before checking for erased information

6.7.16.2 Fail criteria (if supported):

a. Fail if any OBD ECU erases any diagnostic information as discussed in section A.5.

6.7.16.3 Actions:

a. DS DM3 to each OBD ECU.

b. Wait 5 seconds before checking for erased information.

6.7.16.4 Fail criteria (if supported):

a. Fail if any ECU does not NACK, or if any OBD ECU erases any diagnostic information. See section A.5 for more information.

6.7.17 DM7/DM30: Command non-continuously monitored test/scaled test results

6.7.17.1 Actions:

a. DS DM7 with TID 250 and each specific SPN+FMI that had non-initialized test results on list created in step 6.7.15.1.b.

6.7.17.2 Fail criteria:

a. Fail if any non-initialized tests reports now report initialized values. Use this to help verify no diagnostic information was cleared with DM3 request.

6.7.18 Complete part 7 operating cycle and implant fault B

6.7.18.1 Actions:

a. Turn the engine off.

b. Keep the ignition key in the off position.

c. Implant Fault B according to engine manufacturer's instruction. (See section 5 for additional discussion)

d. Turn ignition key to the ON position.

e. Start the engine for cycle 8a.

f. Wait for manufacturer's recommended time for Fault B to be detected as failed.

g. Turn engine off.

h. Wait engine manufacturer's recommended interval for permanent fault recording.

i. Start Engine.

j. If Fault B is a single trip fault proceed with part 8 immediately.

k. Wait for manufacturer's recommended time for Fault B to be detected as failed.

l. Turn engine off.

m. Wait engine manufacturer's recommended interval for permanent fault recording.

n. Start Engine.

o. Proceed with part 8 (cycle 8b).

6.8 Part 8 Verify fault B for general denominator demonstration

Verify Fault B display in DM12 prior to demonstration of permanent fault deletion by the "general denominator principle". Fault B must be detected during the current operating cycle in step 6.8.2. Test step 6.7.18 provides for the both the first operating cycle (see cycle 8a in Figure 2) and the second operating cycle for a fault that requires 2 operating cycles to detect as show in Figure 2 for part 8. When Fault B is detected during the first operating cycle, as a single cycle fault, the second cycle in test step 6.7.18 is to be skipped. Test 6.8.7 assumes that the permanent fault is available. OBD system implementations that record permanent faults after key off will need to turn the engine off and restart the engine before starting part 8. These instructions are included in 6.18.1.

6.8.1 Verify engine running operation

6.8.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.8.1.2 Warn criteria:

a. If after 5 s engine speed is < 400 rpm, prompt/warn operator to confirm engine is running and then press enter.

6.8.2 DM12: Emissions related active DTCs

6.8.2.1 Actions:

a. Global DM12 (send Request (PGN 59904) for PGN 65236 (SPNs 1213-1215, 1706, and 3038)).

b. Repeat request until one or more ECUs reports an active DTC.

   i. Time-out after 5 minutes and ask user yes/no to continue if there is still no active DTC.

   ii. Fail if user says “no” and no ECU reports an active DTC.

6.8.2.2 Warn criteria:

a. Warn if any ECU reports > 1 active DTC.

b. Warn if more than one ECU reports an active DTC.

6.8.2.3 Actions2:

a. DS DM12 to each OBD ECU.

6.8.2.4 Fail criteria2:

a. Fail if any difference compared to data received with global request.

b. Fail if no ECU reports MIL on. See Section A.8 for allowed values.

c. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.8.2.5 Warn criteria2:

a. Warn if ECU reporting active DTC does not report MIL on.

b. Warn if an ECU not reporting an active DTC reports MIL on. .

6.8.3 DM1: Active diagnostic trouble codes (DTCs)

6.8.3.1 Actions:

a. Receive broadcast data (PGN 65226 (SPNs 1213-1215, 1706, and 3038)).

6.8.3.2 Fail criteria:

a. Fail if no ECU reporting MIL on.

b. Fail if any OBD ECU does not include all DTCs from its DM12 response in its DM1 response.

c. Fail if any OBD ECU reporting different MIL status than DM12 response earlier in this part.

6.8.4 DM23: Emission related previously active DTCs

6.8.4.1 Actions:

a. Global DM23 (send Request (PGN 59904) for PGN 64949 (SPNs 1213-1215, 1706, and 3038)).

6.8.4.2 Fail criteria:

a. Fail if no OBD ECU reports a previously active DTC.

b. Fail if previously active DTC reported is not the same as previously active DTC from part 7.

c. Fail if any ECU reporting different MIL status than DM12 response earlier in this part.

6.8.5 DM2: Previously active diagnostic trouble codes (DTCs)

6.8.5.1 Actions:

a. Global DM2 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 3038, 1706)).

6.8.5.2 Fail criteria (if supported):

a. Fail if any OBD ECU does not include all DTCs from its DM23 response in its DM2 response.

b. Fail if any OBD ECU reporting a different MIL status than DM12 response earlier in this part.

6.8.6 DM5: Diagnostic readiness 1

6.8.6.1 Actions:

a. Global DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1218-1223)).

6.8.6.2 Fail criteria:

a. Fail if any OBD ECU reports different number of DTCs than corresponding DM1 or DM2 response earlier this part.

6.8.6.3 Actions2:

a. DS DM5 to each OBD ECU.

6.8.6.4 Fail Criteria2:

a. Fail if any difference in data compared to global response.

6.8.7 DM28: Permanent DTCs

6.8.7.1 Actions:

a. Global DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 1706, and 3038)).

6.8.7.2 Fail criteria:

a. Fail if no OBD ECU reports a permanent DTC.

b. Fail if permanent DTC does not match DM12 DTC from earlier in test 6.8.2.

c. Fail if any ECU reporting different MIL status than DM12 response earlier in test 6.8.2.

6.8.7.3 Warn criteria:

a. Warn if more than one ECU reports a permanent DTC.

b. Warn if any ECU reports more than one permanent DTC.

6.8.7.4 Actions:

a. DS DM28 to each OBD ECU.

6.8.7.5 Fail criteria:

a. Fail if any difference in data compared to global response.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.8.8 DM29: Regulated DTC counts

6.8.8.1 Actions:

a. Global DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)).

6.8.8.2 Fail criteria:

a. Fail if any ECU reports > 0 for emission-related pending.

b. Fail if no ECU reports > 0 for MIL on.

c. Fail if any ECU reports a different number for MIL on than what that ECU reported in DM12 earlier in this part.

d. Fail if no ECU reports > 0 for previous MIL on.

e. Fail if any ECU reports a different number for previous MIL on than what that ECU reported in DM23 earlier in this part.

f. Fail if no ECU reports > 0 for permanent.

g. Fail if any ECU reports a different number for permanent than what that ECU reported in DM28 earlier in this part.

h. For ECUs that support DM27, fail if any ECU reports > 0 for all pending DTCs (SPN 4105).

i. For ECUs that do not support DM27, fail if any ECU does not report number of all pending DTCs = 0xFF

6.8.8.3 Warn criteria:

a. Warn if any ECU reports > 1 for MIL on.

b. Warn if more than one ECU reports > 0 for MIL on.

c. Warn if any ECU reports > 1 for previous MIL on.

d. Warn if more than one ECU reports > 0 for previous MIL on.

e. Warn if any ECU report > 1 for permanent.

f. Warn if more than one ECU reports > 0 for permanent.

6.8.9 DM31: DTC to lamp association

6.8.9.1 Actions:

a. Global DM31 (send Request (PGN 59904) for PGN 41728 (SPNs 1214, 1215, 4113, 4117)).

6.8.9.2 Fail criteria (if supported):

a. Fail if no ECU reports same DTC as MIL on for as was reported in DM12 earlier in this part. See section A.8 for allowed values of SPN 4113 and 4117.

b. Fail if any ECU reports additional or fewer DTCs than those reported in DM12 and DM23 responses earlier in this part.

c. Fail if no ECU reports the same DTC as MIL off for the previous active DTC reported in DM23 earlier in this part.

6.8.10 DM25: Expanded freeze frame

6.8.10.1 Actions:

a. DS DM25 (send Request (PGN 59904) for PGN 64951 (SPNs 3300, 1214, 1215)) to each OBD ECU.

6.8.10.2 Fail criteria:

a. Fail if no ECU reports freeze frame data either for the DTC reported in DM12 or the DTC reported in DM23 earlier in this part. Note more than one freeze frame may be reported in a single response.

b. Fail if NACK not received from OBD ECUs that did not provide a DM25 message.

6.8.11 DM7/DM30: Command non-continuously monitored test/scaled test results

6.8.11.1 Actions:

a. DS DM7 with TID 247 + each DM24 SPN + FMI 31.

b. Create list of any ECU address+SPN+FMI with non-initialized values.

6.8.12 DM22: Individual clear/reset of active and previously active DTC

6.8.12.1 Actions:

a. DS DM22 (PGN 49920) to OBD ECU(s) without a DM12 MIL on DTC stored using the MIL On DTC SPN and FMI and control byte = 17, Request to Clear/Reset Active DTC.

6.8.12.2 Fail criteria (if supported):

a. Fail if the ECU provides CLR_PA_ACK or CLR_ACT_ACK (as described in SAE J1939-73 paragraph 5.7.22).

b. Fail if the ECU provides J1939-21 ACK for PGN 49920.

c. Fail if the ECU provides CLR_ACT_NACK or CLR_PA_NACK with an acknowledgement code greater than 0.[33]

[33] DM22 as described in SAE J1939-73 paragraph 5.7.22 is a request that provides its own acknowledgement mechanism, as given in the control byte value. Values for acknowledgement code greater than 0 signal process failures that would suggest the device supported the deletion of an individual DTC under different conditions. Here, use of the SAE J1939-21 acknowledgement mechanism is considered to be an equivalent failure to the DM22 acknowledgement mechanism. It is possible for the CAN controller hardware filters to reject the DM22 message if it is not supported by an implementation. In such cases the implementation will produce no response whatsoever. A warning is provided in this case.

6.8.12.3 Warn criteria:

a. Warn if DM22 (PGN 49920) CA_PA_NACK or CA_ACT_NACK is not received with an acknowledgement code of 0. [34]

b. Warn if J1939-21 NACK for PGN 49920 is received.

6.8.12.4 Actions2:

a. DS DM22 to OBD ECU with a DM12 MIL on DTC stored using the DM12 MIL On DTC SPN and FMI and control byte = 1, Request to Clear/Reset Previously Active DTC.

6.8.12.5 Fail criteria2:

a. Fail if the ECU provides DM22 with CLR_PA_ACK or CLR_ACT_ACK.

b. Fail if the ECU provides J1939-21 ACK for PGN 49920.

c. Fail if the ECU provides CLR_ACT_NACK with an acknowledgement code greater than 0.

6.8.12.6 Warn criteria2:

a. Warn if DM22 (PGN 49920) CA_PA_NACK or CA_ACT_NACK is not received with an acknowledgement code of 0.

b. Warn if J1939-21 NACK for PGN 49920 is received.

6.8.12.7 Actions3:

a. Global DM22 using DM12 MIL On DTC SPN and FMI with control byte = 1, Request to Clear/Reset Previously Active DTC.

6.8.12.8 Fail criteria3:

a. Fail if any ECU provides DM22 with CLR_PA_ACK or CLR_ACT_ACK.

b. Fail if any ECU provides J1939-21 ACK for PGN 49920.

c. Fail if any ECU provides CLR_ACT_NACK or CLR_PA_NACK with an acknowledgement code greater than 0.

6.8.12.9 Actions4:

a. Global DM22 using DM12 MIL On DTC SPN and FMI with control byte = 17, Request to Clear/Reset Active DTC.

6.8.12.10 Fail criteria4:

a. Fail if any ECU provides CLR_PA_ACK or CLR_ACT_ACK.

b. Fail if any ECU provides J1939-21 ACK for PGN 49920.

c. Fail if any ECU provides CLR_ACT_NACK or CLR_PA_NACK with an acknowledgement code greater than 0.

d. Fail if any OBD ECU erases any diagnostic information. See section A.5 for more information. [35]

[34] For those ECUs that do not support DM22, no response what-so-ever is a likely occurrence as described in SAE J1939-73 paragraph 5.7.22. Hence, this particular warning message in 6.8.12.3 and 6.8.12.6, by itself, does not indicate any need for software change in the subject HD OBD ECU.

[35] It would be inefficient to check for erased information four times. Checking the system at the end of all the DM22 queries in test 8 will suffice to determine pass or fail for erased information.

6.8.13 DM3: Diagnostic data clear/reset for previously active DTCs

6.8.13.1 Actions:

a. DS DM3 (send Request (PGN 59904) for PGN 65228) to each OBD ECU.

b. Wait 5 seconds before checking for erased information

6.8.13.2 Fail criteria (if supported):

a. Fail if any ECU does not NACK or if any diagnostic information erased.

6.8.13.3 Actions:

a. Global DM3.

b. Wait 5 seconds before checking for erased information

6.8.13.4 Fail criteria (if supported):

a. Fail if any OBD ECU erases any diagnostic information

6.8.14 DM7/DM30: Command non-continuously monitored test/scaled test results

6.8.14.1 Actions:

a. DS DM7 with TID 250 and specific SPN+FMI for each combination with non-initialized test results from list created earlier in this part.

6.8.14.2 Fail criteria:

a. Fail if any test results now have initialized values. Use this to help identify if any diagnostic information was erased.

6.8.15 DM26: Diagnostic readiness 3

6.8.15.1 Actions:

a. DS DM26 (send Request (PGN 59904) for PGN 64952 (SPN 3302)) to each OBD ECU.

b. Record all values of provided for number of warm-ups since code clear (SPN 3302).

6.8.15.2 Fail criteria:

a. Fail if NACK not received from OBD ECUs that did not provide DM26 message.

6.8.16 Complete part 8b operating cycle and repair fault B for part 9

6.8.16.1 Actions:

a. Turn the engine off.

b. Wait manufacturer's recommended interval.

c. With the key in the off position remove the implanted fault B, according to the manufacturer’s instructions for restoring the system to a fault free operating condition.

d. Turn the ignition key to the ON position.

e. Do not start engine.

f. Proceed with part 9.

6.9 Part 9 verify deletion of fault B with DM11

Part 9 Purpose: Demonstrate Fault B deletion using DM11 during KOEO operation. Verify data before code clear, verify code clear works, and verify permanent fault and other data remains.

6.9.1 Verify engine off operation

6.9.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.9.1.2 Warn criteria:

a. If engine speed is > 0 rpm, prompt/warn operator to confirm engine is not running and then press enter.

6.9.2 DM12: Emissions related active DTCs

6.9.2.1 Actions:

a. Global DM12 (send Request (PGN 59904) for PGN 65236 (SPNs 1213-1215, 1706, and 3038)).

b. Create list of which OBD ECU(s) have a DM12 active MIL on DTC and which do not. This list will be used for test 6.9.8.

6.9.2.2 Fail criteria:

a. Fail if no OBD ECU reporting one or more active MIL on DTCs

b. Fail if no OBD ECUs reporting MIL commanded on. See Section A.8 for allowed values.

c. Fail if any ECU reports a different active MIL on DTC(s) than what that ECU reported in part 8 DM12 response.

6.9.2.3 Warn criteria:

a. Warn if any ECU reports > 1 active DTC.

b. Warn if more than one ECU reports an active DTC.

6.9.3 DM22: Individual clear/reset of active and previously active DTC

6.9.3.1 Actions:

a. DS DM22 (PGN 49920) to OBD ECU(s) without a DM12 MIL on DTC stored using the MIL On DTC SPN and FMI and control byte = 17, Request to Clear/Reset Active DTC.

6.9.3.2 Fail criteria (if supported):

a. Fail if the ECU provides CLR_PA_ACK or CLR_ACT_ACK (as described in SAE J1939-73 paragraph 5.7.22).

b. Fail if the ECU provides J1939-21 ACK for PGN 49920.

c. Fail if the ECU provides CLR_ACT_NACK or CLR_PA_NACK with an acknowledgement code greater than 0.[36]

6.9.3.3 Warn criteria:

a. Warn if DM22 (PGN 49920) CA_PA_NACK or CA_ACT_NACK is not received with an acknowledgement code of 0.

b. Warn if J1939-21 NACK for PGN 49920 is received.

6.9.3.4 Actions2:

a. DS DM22 to OBD ECU with a DM12 MIL On DTC stored using the DM12 MIL On DTC SPN and FMI and control byte = 1, Request to Clear/Reset Previously Active DTC.

6.9.3.5 Fail criteria2:

a. Fail if the ECU provides DM22 with CLR_PA_ACK or CLR_ACT_ACK.

b. Fail if the ECU provides J1939-21 ACK for PGN 49920.

c. Fail if the ECU provides CLR_ACT_NACK with an acknowledgement code greater than 0.

6.9.3.6 Warn criteria2:

a. Warn if DM22 (PGN 49920) CA_PA_NACK or CA_ACT_NACK is not received with an acknowledgement code of 0.

b. Warn if J1939-21 NACK for PGN 49920 is received.

6.9.3.7 Actions3:

a. Global DM22 using DM12 MIL On DTC SPN and FMI with control byte = 1, Request to Clear/Reset Previously Active DTC.

6.9.3.8 Fail criteria3:

a. Fail if any ECU provides DM22 with CLR_PA_ACK or CLR_ACT_ACK.

b. Fail if any ECU provides J1939-21 ACK for PGN 49920.

c. Fail if any ECU provides CLR_ACT_NACK or CLR_PA_NACK with an acknowledgement code greater than 0.

6.9.3.9 Actions4:

a. Global DM22 using DM12 MIL On DTC SPN and FMI with control byte = 17, Request to Clear/Reset Active DTC.

[36] The failure criteria in section 9 for DM22 are the same as the criteria in Section 8. See footnote 27. Table 20 in SAE J1939-73 describes the non-acknowledgement codes for CLR_PA_NACK and CLR_ACT_NACK.

6.9.3.10 Fail criteria4:

a. Fail if any ECU provides CLR_PA_ACK or CLR_ACT_ACK.

b. Fail if any ECU provides J1939-21 ACK for PGN 49920.

c. Fail if any ECU provides CLR_ACT_NACK or CLR_PA_NACK with an acknowledgement code greater than > 0.

d. Fail if any OBD ECU erases any diagnostic information. See section A.5 for more information. [37]

6.9.4 DM20: Monitor performance ratio

6.9.4.1 Actions:

a. Global DM20 (send Request (PGN 59904) for PGN 49664 (SPNs 3048-3049, 3066-3068)).

b. Record all values (numerators, denominators, and ignition cycles).

6.9.5 DM21: Diagnostic readiness 2

6.9.5.1 Actions:

a. DS DM21 (send Request (PGN 59904) for PGN 49408 (SPNs 3294, 3296)) to each OBD ECU.

6.9.5.2 Fail criteria:

a. Fail if any ECU reports distance SCC (SPN 3294) > 0.

b. Fail if any ECU reports time SCC (SPN 3296) is < 1 minute (if SPN 3296 is supported).

c. Fail if no OBD ECU provides a DM21 message

d. Fail if NACK not received from OBD ECUs that did not support a DM21 message.

6.9.5.3 Warn criteria:

a. Warn if more than one ECU reports time SCC > 0 and times reported differ by > 1 minute.

6.9.6 DM7/DM30: Command non-continuously monitored test/scaled test results

6.9.6.1 Actions:

a. DS DM7 with TID 247 and specific SPN+FMI 31 for each SPN found to have non-initialized test results from list created in step 6.8.11.1.

6.9.6.2 Fail criteria:

a. Fail if any test result is now initialized (i.e., provides 0xFB00/0xFFFF/0xFFFF or 0x0000/0x0000/0x0000 for result/min/max).

[37] As in part 6 test 8, it would be inefficient to check for erased information four times. Checking the system at the end of all the DM22 queries in test 3 will suffice to determine pass or fail for erased information.

6.9.7 DM33: Emission increasing auxiliary emission control device active time

6.9.7.1 Actions:

a. Global DM33 (send Request (PGN 59904) for PGN 41216 (SPNs 4124-4126)).

b. Create a list of ECU address + EI-AECD number + actual time (for Timer 1 and/or Timer 2) for any with non-zero timer values.

6.9.7.2 Fail criteria:

a. Fail if any ECU reports a different number of EI-AECD timers than was reported in part 2.

6.9.8 DM11: Diagnostic data clear/reset for active DTCs

6.9.8.1 Actions:

a. DS DM11 (send Request (PGN 59904) for PGN 65235) to each OBD ECU without DM12 active MIL on DTC, based on the list created in step 6.9.2.1.[38]

b. Wait 5 seconds before checking for erased data.

6.9.8.2 Fail criteria:

a. Fail if any ECU partially erases diagnostic information (pass if it erases either all or none).

b. Fail if one or more than one ECU erases diagnostic information and one or more other ECUs do not erase diagnostic information. See section A.5.

6.9.8.3 Actions2:

a. DS DM11 to each OBD ECU with DM12 active MIL on DTC, based on the list created in step 6.9.2.1.

b. Wait 5 seconds before checking for erased data.

6.9.8.4 Fail criteria2:

a. Fail if any ECU partially erases diagnostic information (pass if it erases either all or none).

b. For systems with multiple ECU's, fail if one ECU or more than one ECU erases diagnostic information and one or more other ECUs do not erase diagnostic information.

6.9.8.5 Actions3:

a. Global DM11(send Request (PGN 59904) for PGN 65235).

b. Wait 5 seconds before checking for erased data.

[38] There may be no OBD ECUs that meet this criterion for monolithic designs or diagnostic gateways. When there is more than 1 ECU in this category the destination specific requests to individual ECUs may overlap. They must not overlap the destination specific request for 6.9.8.3 to the OBD ECU that detected the failure and provides (a) DTC(s) in DM12.

6.9.8.6 Fail/warn criteria3:

a. Fail if any OBD ECU provides a NACK to the global DM11 request.

b. Warn if any OBD ECU provides an ACK to the global DM11 request.

c. Fail if any diagnostic information was not erased from any OBD ECUs.

6.9.9 DM21: Diagnostic readiness 2

6.9.9.1 Actions:

a. DS DM21 (send Request (PGN 59904) for PGN 49408 (SPNs 3295-3296)) to each OBD ECU.

6.9.9.2 Fail criteria:

a. Fail if any report time SCC (SPN 3296) > 0 (if supported)

b. Fail if any report time with MIL on (SPN 3295) > 0.(if supported)

c. Fail if no OBD ECU supports DM21.

d. Fail if NACK not received from OBD ECUs that did not provide DM21 message.

6.9.10 DM7/DM30: Command non-continuously monitored test/scaled test results

6.9.10.1 Actions:

a. DS DM7 with TID 250 and each SPN+FMI from list in part 1 to the OBD ECU that supports the SPN and FMI with test results.

6.9.10.2 Fail criteria:

a. Fail if any test result not initialized.

b. Fail if any difference in what ECU+SPN+FMI combinations have test results compared to the combinations identified in part 1 as having test results.

6.9.11 DM20: Monitor performance ratio

6.9.11.1 Actions:

a. DS DM20 (send Request (PGN 59904) for PGN 49664 (SPNs 3048-3049, 3066-3068)) to ECUs that responded earlier in this part with DM20 data.

6.9.11.2 Fail criteria:

a. Fail if any value (ignition cycle, numerator, or denominator) is not equal to the value that it was earlier in Step 6.9.4.1.b (before DM11).

b. Fail if any ECU now NACKs DM20 requests after previously providing data in 6.9.4.1.

c. Fail if any NACK not received from an OBD ECU that did not provide a DM20 message.

6.9.12 DM28: Permanent DTCs

6.9.12.1 Actions:

a. DS DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 1706, and 3038)) to each OBD ECU.

6.9.12.2 Fail criteria:

a. Fail if no ECU reports a permanent DTC present.

b. Fail if any ECU does not report MIL off. See section A.8 for more information.

c. Fail if NACK not received from OBD ECUs that did not provide a DM28 message.

6.9.12.3 Warn criteria:

a. Warn if permanent DTC is different than DM12 DTC earlier in this part.

6.9.13 DM31: DTC to lamp association

6.9.13.1 Actions:

a. DS DM31 (send Request (PGN 59904) for PGN 41728 (SPNs 1214-1215, 4113, 4117)) to each ECU(s) that has any DM28 permanent DTCs.

6.9.13.2 Fail criteria (if supported):

a. Fail if MIL is not reported off for all reported DTCs.

b. Fail if NACK not received from OBD ECUs that did not provide a DM31 message.

6.9.14 DM27: All pending DTCs

6.9.14.1 Actions:

a. Global DM27 (send Request (PGN 59904) for PGN 64898 (SPNs 1213-1215, 1706, and 3038)).

6.9.14.2 Fail criteria (if supported):

a. Fail if any OBD ECU reports a pending DTC.

6.9.14.3 Actions:

a. DS DM27 to each OBD ECU.

6.9.14.4 Fail criteria (if supported):

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.9.15 DM29: Regulated DTC counts

6.9.15.1 Actions:

a. Global DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)).

6.9.15.2 Fail criteria:

a. Fail if any ECU reports > 0 for emission-related pending, MIL-on, or previous MIL on.

b. Fail if no ECU reports > 0 for Permanent DTC.

c. Fail if any ECU reports a different number for permanent DTC than what that ECU reported in DM28.

d. For OBD ECUs that support DM27, fail if any ECU reports > 0 for all pending DTCs (SPN 4105).

e. For OBD ECUs that do not support DM27, fail if any ECU does not report number of all pending DTCs = 0xFF.

6.9.15.3 Warn criteria:

a. Warn if any ECU reports > 1 for Permanent DTC.

b. Warn if more than one ECU reports > 0 for Permanent DTC.

6.9.16 DM26: Diagnostic readiness 3

6.9.16.1 Actions:

a. DS DM26 (send Request (PGN 59904) for PGN 64952 (SPN 3302)) to each OBD ECU.

6.9.16.2 Fail criteria:

a. Fail if any ECU that was reporting a non-zero value of number of WU-SCC (SPN 3302) in test 6.8.16.1.a is still reporting > 0.

a. Fail if NACK not received from OBD ECUs that did not provide a DM26 message.

6.9.17 DM25: Expanded freeze frame

6.9.17.1 Actions:

a. DS DM25 (send Request (PGN 59904) for PGN 64951 (SPNs 3300, 1214-1215)) to each OBD ECU.

6.9.17.2 Fail criteria:

a. Fail if any OBD ECU reports other than no Freeze Frame data stored (bytes 1-5 = 0x00, 6-8= 0xFF).

b. Fail if NACK now received from OBD ECUs that previously provided a DM25 message.

6.9.18 DM23: Emission Related Previously Active DTCs

6.9.18.1 Actions:

a. DS DM23 (send Request (PGN 59904) for PGN 64949 (SPNs 1213-1215, 1706, and 3038)) to each OBD ECU.

6.9.18.2 Fail criteria:

a. Fail if any ECU reports a previously active DTC.

b. Fail if any ECU does not report MIL off. See section A.8 for allowed values.

c. Fail if NACK not received from OBD ECUs that did not provide DM23 message.

6.9.19 DM12: Emissions related active DTCs

6.9.19.1 Actions:

a. DS DM12 (send Request (PGN 59904) for PGN 65236 (SPNs 1213-1215, 1706, and 3038)) to each OBD ECU.

6.9.19.2 Fail criteria:

a. Fail if any ECU reports an active MIL DTC.

b. Fail if any ECU does not report MIL off.

c. Fail if no DM12 message is received from any OBD ECU.

d. Fail if NACK not received from OBD ECUs that did not support DM12 message.

6.9.20 DM6: Emission related pending DTCs

6.9.20.1 Actions:

a. Global DM6 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 1706, and 3038)).

6.9.20.2 Fail criteria:

a. Fail if any ECU reports a pending DTC.

b. Fail if no OBD ECU provides a DM6 message.

6.9.20.3 Actions:

a. DS DM6 to each OBD ECU.

6.9.20.4 Fail criteria:

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.9.21 DM5: Diagnostic readiness 1

6.9.21.1 Actions:

a. Global DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1218-1219)).

6.9.21.2 Fail criteria:

a. Fail if any OBD ECU reports > 0 active DTCs or > 0 previously active DTCs.

6.9.22 DM2: Previously active diagnostic trouble codes (DTCs)

6.9.22.1 Actions:

a. Global DM2 (send Request (PGN 59904) for PGN 65227 (SPNs 1213-1215, 1706, and 3038)).

6.9.22.2 Fail criteria (if supported):

a. Fail if any ECU does not report MIL off or MIL not supported. See section A.8 for allowed values.

b. Fail if any OBD ECU reports a previously active DTC.

6.9.22.3 Actions:

a. DS DM2 to each OBD ECU.

6.9.22.4 Fail criteria (if supported):

a. Fail if any difference compared to data received during global request.

b. Fail if NACK not received from OBD ECUs that did not respond to global query.

6.9.23 DM1: Active diagnostic trouble codes (DTCs)

6.9.23.1 Actions:

a. Receive DM1 broadcast (PGN 65226 (SPNs 1213-1215, 1706, and 3038)).

6.9.23.2 Fail criteria:

a. Fail if any ECU does not report MIL off or MIL not supported.

b. Fail if any ECU reports an active DTC.

c. Fail if no OBD ECU provides DM1.

6.9.24 DM33: Emission increasing auxiliary emission control device active time

6.9.24.1 Actions:

a. DS DM33 (send Request (PGN 59904) for PGN 41216 (SPNs 4124-4126)) to each OBD ECU.

6.9.24.2 Fail criteria:

a. Fail if any ECU reports a different number EI-AECD than was reported in part 2.

b. Compare to list of ECU address + EI-AECD number + actual time (for Timer 1 and/or Timer 2) for any with non-zero timer values created earlier in step 6.9.6.1 and fail if any timer value is less than the value it was earlier in this part.

c. Fail if NACK not received from OBD ECUs that did not provide a DM33 message.

6.9.25 Part 9 to Part 10 Transition

6.9.25.1 Actions:

a. Turn Key Off.

b. Wait manufacturer's recommended interval.

c. Turn Ignition key to on position.

d. Start engine.

e. Proceed with part 10.

6.10 Part 10 Prime diagnostic executive for general denominator demonstration

Part 10 Purpose: Run monitor to pass Fault B diagnostic twice as shown for cycle 10a and cycle 10b in Figure 2, but do not meet general denominator criteria necessary to erase a permanent fault. Verify permanent fault remains during cycle 10b.

6.10.1 Verify engine running operation for cycle 10a

6.10.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.10.1.2 Warn criteria:

a. If engine speed is < 400 rpm, prompt/warn operator to confirm engine is running and then press enter.

6.10.2 Complete cycle 10a

6.10.2.1 Actions:

a. Wait for manufacturer's recommended time for Fault B to be detected as passed.

b. Wait a total of at least 2 minutes to establish cycle

c. Turn engine off

d. Wait 1 minute.

e. Start engine.

6.10.3 Verify engine running operation for cycle 10b

6.10.3.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.10.3.2 Warn criteria:

a. If engine speed is < 400 rpm, prompt/warn operator to confirm engine is running and then press enter.

6.10.4 DM28: Permanent DTCs

6.10.4.1 Actions:

a. DS DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 1706, and 3038)) to each OBD ECU.

6.10.4.2 Fail criteria:

a. Fail if no ECU reports a permanent DTC.

b. Fail if any ECU does not report MIL off. See section A.8 for allowed values.

c. Fail if NACK not received from OBD ECUs that did not provide a DM28 message.

6.10.5 Part 10 to Part 11 Transition

6.10.5.1 Actions:

a. Wait for manufacturer's recommended time for Fault B to be detected as passed.

b. Wait a total of at least 2 minutes to establish 2nd cycle.

c. Turn engine off.

d. Wait 1 minute.

e. Start engine.

f. Proceed with part 11, General Denominator Demonstration.

6.11 Part 11 Exercise general denominator

Part 11 Purpose: Run monitor to pass Fault B diagnostic and to meet general denominator criteria necessary to erase a permanent fault. Verify permanent fault and other data in KOER. The general denominator demonstration requires at least 10 minutes of engine run time. Five minutes of the 10 must be above 1150 rpm. At least 30 s of the 10 minutes must be at idle. Refer to section 5 for needed operation control settings.

6.11.1 Verify engine operation

6.11.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.11.1.2 Warn criteria:

a. If engine speed is < 400 rpm, prompt/warn operator to confirm engine is running and then press enter.

6.11.2 DM26: Diagnostic readiness 3

6.11.2.1 Actions:

a. Global DM26 (send Request (PGN 59904) for PGN 64952 (SPN 3301)).

   i. Record time since engine start.

   ii. Separately start tracking time in software to compare to reported values later in part 11.

6.11.2.2 Fail criteria:me

a. If more than one ECU responds, fail if times (since engine start) differ by > 2 s.

b. Fail if no OBD ECU provides a DM26 message.

6.11.3 DM21: Diagnostic readiness 2

6.11.3.1 Actions:

a. DS DM21 (send Request (PGN 59904) for PGN 49408 (SPNs 3294, 3296)) to each OBD ECU.

b. Record distance (SPN 3294) and time (SPN 3296) SCC (if supported) to compare later in test 6.11.12.

6.11.3.2 Fail Criteria:

a. Fail if NACK not received from OBD ECUs that did not provide a DM21 message.

6.11.4 DM29: Regulated DTC counts

6.11.4.1 Actions:

a. Global DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)).

6.11.4.2 Fail criteria:

a. Fail if any ECU reports > 0 for emission-related pending, MIL-on, or previous MIL on.

b. Fail if no ECU reports > 0 for Permanent DTC.

c. For ECUs that support DM27, fail if any ECU reports > 0 for all pending DTCs (SPN 4105).

d. For ECUs that do not support DM27, fail if any ECU does not report number of all pending DTCs = 0xFF.

6.11.4.3 Warn criteria:

a. Warn if any ECU reports > 1 for Permanent DTC.

b. Warn if more than one ECU reports > 0 for Permanent DTC.

6.11.5 DM20: Monitor performance ratio

6.11.5.1 Actions:

a. Global DM20 (send Request (PGN 59904) for PGN 49664 (SPNs 3048-3049, 3066-3068)).

b. Record all data (ignition cycles, numerators, and denominators).

6.11.6 DM28: Permanent DTCs

6.11.6.1 Actions:

a. Global DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 1706, and 3038)).

6.11.6.2 Fail criteria:

a. Fail if no ECU reports a permanent DTC.

b. Fail if any ECU reports a different number of permanent DTCs than indicated in DM29 response earlier in test 6.11.4.

6.11.7 DM20/DM28/Broadcast data: Waiting until general denominator is met

6.11.7.1 Actions:

a. Broadcast data received shall comply with the values defined in section A.1.

b. Wait 3 minutes.

c. Increase engine speed over 1150 RPM (a minimum of 300 s at this speed is required)

d. Periodic DS DM20 to ECUs that reported data earlier in this part and DS DM28s to ECU that reported permanent DTC earlier in this part (no more than once every 1 s) while timing engine operation versus the general denominator timing requirement.

e. [Every 10th query set may be reported in the log unless the failure criteria for DM20 or DM28 were met].

f. After 300 s have been exceeded, reduce the engine speed back to idle.

6.11.7.2 Fail criteria:

a. Fail if there is any DM20 response that indicates any denominator is greater than the value it was earlier in this part before general denominator timing has elapsed.

b. Fail if there is any DM28 response that indicates the permanent DTC is no longer present before general denominator timing has elapsed.

c. Fail if any broadcast data is missing according to Table 3, or otherwise meets failure criteria during engine idle speed periods.

6.11.7.3 Warn criteria:

a. Identify any broadcast data meeting warning criteria in Table 3 during engine idle periods. .

6.11.7.4 Actions2:

a. Once 620 s of engine operation overall in part 11 have elapsed (including over 300 s of engine operation over 1150 RPM), end periodic DM20 and DM28 and continue with test 6.11.8.

6.11.8 DM20: Monitor performance ratio

6.11.8.1 Actions:

a. DS DM20 (send Request (PGN 59904) for PGN 49664 (SPNs 3048-3049, 3066-3068)) to ECUs that reported DM20 data earlier in this part.

6.11.8.2 Fail criteria:

a. Fail if any response indicates that the general denominator (SPN 3049) has not incremented by one from value earlier in part 9.

b. Fail if NACK received from OBD ECUs that previously provided a DM20 message.

6.11.8.3 Warn criteria:

a. Warn if any response indicates denominator for SCR, EGR, NOx sensor, boost, and fuel system have not incremented by one.

b. Warn if any ECU response shows:

   i. any monitor denominator greater than the general denominator;

   ii. general denominator greater than the ignition cycle counter (SPN 3048); or

   iii. if any numerator greater than the ignition cycle counter.

c. Compare all values to values recorded in part 1

   i. Warn if any value (numerator, denominator, or ignition cycle counter) is less than their corresponding value in part 1.

d. If more than one ECU reports DM20 data, warn if general denominators or ignition cycle counts do not match from all ECUs.

6.11.9 DM28: Permanent DTCs

6.11.9.1 Actions:

a. DS DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 3038, 1706)) to each OBD ECU.

6.11.9.2 Fail criteria:

a. Fail if no ECU reports a permanent DTC.

b. Fail if the permanent DTC reported is not the same DTC as reported in DM28 in part 10.

c. Fail if NACK not received from OBD ECUs that did not provide a DM28 message.

6.11.10 DM5: Diagnostic readiness 1

6.11.10.1 Actions:

a. DS DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1218-1223)) to each OBD ECU.

a. Record all data (i.e., which monitors are supported and complete or supported and incomplete).

a. Display monitor readiness composite value in log.

6.11.11 DM26: Diagnostic Readiness 3

6.11.11.1 Actions:

a. DS DM26 (send Request (PGN 59904) for PGN 64952 (SPNs 3301-3305)) to each OBD ECU.

b. Record all monitor readiness this trip data (i.e., which supported monitors are complete this trip or supported and not complete this trip).

6.11.11.2 Fail criteria:

a. Fail if response indicates time since engine start (SPN 3301) differs by more than ± 10 s from expected value (calculated by software using original DM26 response in this part plus accumulated time since then).

b. Fail if NACK not received from OBD ECUs that did not provide a DM26 message.

6.11.12 DM21: Diagnostic readiness 2

6.11.12.1 Actions:

a. DS DM21 (send Request (PGN 59904) for PGN 49408 (SPNs 3294, 3296)) to each OBD ECU.

6.11.12.2 Fail criteria:

a. If time SCC is supported, Fail if time SCC (SPN 3296) accumulation from time captured in Test 6.11.3 is less than DM26 reported time since start (rounded down to the minute).

b. Fail if distance SCC (SPN 3294) is > 0.

c. Fail if NACK not received from OBD ECUs that did not provide a DM21 message.

6.11.13 Part 11 to Part 12 Transition

6.11.13.1 Actions:

a. Turn Engine Off.

b. Wait manufacturer's recommended interval.

c. Turn Key On.

d. Start Engine Immediately.

e. Wait 60 s.

f. Turn engine off.

g. Wait manufacturer's recommended interval.

h. Turn Key On.

i. Proceed to Part 12.

6.12 Part 12 Verify deletion of fault B from DM28

Part 12 Purpose: After general denominator criteria have been completed, verify permanent fault for Fault B was erased.

6.12.1 Verify engine operation

6.12.1.1 Actions:

a. Gather broadcast data for engine speed (e.g., SPN 190).

6.12.1.2 Warn criteria:

a. If engine speed is > 0 rpm, prompt/warn operator to confirm engine is not running and then press enter.

6.12.2 DM26: Diagnostic readiness 3

6.12.2.1 Actions:

a. DS DM26 (send Request (PGN 59904) for PGN 64952 (SPNs 3303-3305)) to each OBD ECU.

6.12.2.2 Fail criteria:

a. Fail if any supported monitor (except CCM) that was “0= complete this cycle” in part 11 is not reporting “1=not complete this cycle”.

b. Fail if NACK not received from OBD ECUs that did not provide a DM26 message.

6.12.3 DM5: Diagnostic readiness 1

6.12.3.1 Actions:

a. DS DM5 (send Request (PGN 59904) for PGN 65230 (SPNs 1221-1223)) to each OBD ECU.

b. Display monitor readiness composite value in log.

6.12.3.2 Fail criteria:

a. Fail if any supported monitor (except CCM) that was “0= complete” in part 11 is now reporting “1=not complete”.

6.12.3.3 Warn criteria:

a. Warn if DM5 reports fewer completed monitors than DM26 in step 6.12.2.1.

6.12.4 DM28: Permanent DTCs

6.12.4.1 Actions:

a. DS DM28 (send Request (PGN 59904) for PGN 64896 (SPNs 1213-1215, 1706, and 3038)) to each OBD ECU.

6.12.4.2 Fail criteria:

a. Fail if any ECU reports a permanent DTC.

b. Fail if NACK not received from OBD ECUs that did not provide a DM28 message.

6.12.5 DM29: Regulated DTC Counts

6.12.5.1 Actions:

a. Global DM29 (send Request (PGN 59904) for PGN 40448 (SPNs 4104-4108)).

6.12.5.2 Fail criteria:

a. Fail if any ECU reports > 0 for emission-related pending, MIL-on, previous MIL on, or permanent DTC.

b. For OBD ECUs that support DM27, fail if any ECU reports > 0 for all pending DTCs (SPN 4105).

c. For OBD ECUs that do not support DM27, fail if any ECU does not report number of all pending DTCs = 0xFF.

d. Fail if no OBD ECU provides a DM29 message.

6.12.6 DM1: Active diagnostic trouble codes (DTCs)

6.12.6.1 Actions:

a. Receive broadcast info (PGN 65226 (SPNs 1213-1215, 1706, 3038)).

6.12.6.2 Fail criteria:

a. Fail if any ECU does not report MIL off or not supported. See section A.8 for allowed values.

b. Fail if any ECU reports active DTCs.

6.12.7 DM21: Diagnostic readiness 2

6.12.7.1 Actions:

a. Global DM21 (send Request (PGN 59904) for PGN 49408 (SPNs 3294, 3296)).

6.12.7.2 Fail criteria:

a. Fail if any ECU reports distance SCC (SPN 3294) > 0.

b. Fail if any ECU reports < 10 minutes for time SCC (SPN 3296), if supported.

c. If more than one ECU responds, fail if values reported for time SCC differ by > 1 minute.

d. Fail if no OBD ECU provides a DM21 message.

6.12.8 DM7/ DM30: Command non-continuously monitored test/scaled test results

6.12.8.1 Actions:

a. DS DM7 with TID 250 and each SPN+FMI from list created in part 1.

b. Record all values for any ECU address+SPN+FMI that has non-initialized values.

6.12.9 DM11: Diagnostic data clear/reset for active DTCs

6.12.9.1 Actions:

a. DS DM11 (send Request (PGN 59904) for PGN 65235) to each OBD ECU

b. Wait 5 seconds before checking for erased data.

6.12.9.2 Fail criteria:

a. Fail if any OBD ECU does not respond with a NACK

b. Check diagnostic information as described in section A.5 and fail if any ECU partially erases diagnostic information (pass if it erases either all or none).

c. For systems with multiple ECUs, fail if one OBD ECU or more than one OBD ECU erases diagnostic information and one or more other OBD ECUs do not erase diagnostic information.

6.12.9.3 Actions:

a. Global DM11.

b. Wait 5 seconds before checking for erased data.

6.12.9.4 Fail criteria:

a. Fail if any OBD ECU responds with a NACK

b. Warn if any OBD ECU responds with an ACK.

c. Check diagnostic information and fail if any ECU partially erases diagnostic information (pass if it erases either all or none).

d. Fail if one OBD ECU or more than one OBD ECU erases diagnostic information and one or more other ECUs do not erase diagnostic information. See section A.5 for the methods to check for erasure of diagnostic information.

6.12.10 DM7/ DM30: Command non-continuously monitored test/scaled test results

6.12.10.1 Actions:

a. DS DM7 with TID 250 for specific ECU address+SPN+FMI that had non-initialized values earlier in Part.

b. Use responses to help verify coordinated DM11 code clear in this part (i.e., all or no ECUs clear).

6.13 Application to Distributed Systems

Parts 6.1 through 6.12 describe tests that generally 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 6.13.1 and 6.13.2 provide guidelines that adapt the procedures in Parts 6.1 through 6.12 for distributed implementations. The parts 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.

6.13.1 Step-wise parallel evaluation of components

The procedure in parts 6.1 through part 6.12 generally implement a step-wise parallel evaluation that iterates each test part 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 Parts 6.1 through 6.12 presume that each device in a distributed system 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.

6.13.2 Sequential evaluation of components

The procedures above can be 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 parts 1 and 2 once. Obtain CAL ID and CVN for each ECU in the distributed system.

2. Iterate Parts 3 through 12 for each ECU in the distributed system. Use two faults for each ECU as implants for Fault A and Fault B of Figure 2.

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 2 – 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 s before proceeding. The MIL may remain illuminated for an indefinite amount of time until the engine is started.

7.1.2 Verify communication, ignition on, engine off

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

Procedure:

Test Computer sends 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, 0x00FECE)	CE
Byte 2		FE
Byte 3		00

Figure 3 - 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 4 - 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 5 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, 0x00FED3)	D3
Byte 2		FE
Byte 3		00

Figure 5 - 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
Byte 3		FF
Byte 4		FF
Byte 5	Source address of Test Computer	XX
Byte 6	PGN of requested message (i.e., DM11 - PGN = 65235, 0x00FED3)	D3
Byte 7		FE
Byte 8		00

Figure 6 - 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 6 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 bits 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, 0x00FED4)	D4
Byte 2		FE
Byte 3		00

Figure 7 - 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 8 - 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 8 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, $0x00FECF_{16}$)	CF
Byte 2		FE
Byte 3		00

Figure 9 - 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 10 - 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, $0x00FCB6_{16}$)	B6
Byte 2		FD
Byte 3		00

Figure 11 - 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 12 - ECU#x response: SPN Supported (DM24) response message

Evaluation criteria:

- If no DM24 response is received from each OBD ECU, a failure shall be flagged.
- If a DM24 response is received from at least one ECU, then the test unit should verify that the SPNs 92, 110, 190, and 84 are reported at least once as Data Stream parameters among all the Data Steam parameter responses. If all four SPNs are not supported, a failure will be flagged.
- Monitor the SAE J1939 Data Link for the presence of these SPNs, noting that the appropriate values for 190 and 84 should be zero for the vehicle at rest and the engine off. If these two SPNs are not reported, or reported with non-zero value, a failure will be flagged.
- Note that a lack of support for DM24 is not necessarily a failure, depending on the level of OBD support that the ECUs have reported. DM24 (and DM25) are required for ECUs supporting the California CCR 1971.1 regulation, but not for previous regulations such as CCR 1968.1.

7.2 Verify communication with engine running

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

Procedure:

- Move ignition to crank position and start engine. Let engine idle for 1 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, $0x00FECD_{16}$)	CD
Byte 2		FE
Byte 3		00

Figure 13 - 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 14 - 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, 0x00FEEC$_{16}$)	EC
Byte 2		FE
Byte 3		00

Figure 15 - 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 16 - 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

Figure 17 - 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, 0x00D300)	00
Byte 2		D3
Byte 3		00

Figure 18 - 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 19 - 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 s) for only one ECU.

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

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

Start engine, let idle for 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 (SAE J1939), engine running

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

Procedure:

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

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	**Data Description**	**Byte Value (Hex)**
Byte 1	PGN of requested message (i.e., DM5 - PGN = 65230, 0x00FECE)	CE
Byte 2		FE
Byte 3		00

Figure 20 - 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 21 - 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 s, Test Computer will send a SAE J1939 Request message for DM6 to Global Address to get pending DTCs. If DTC is set, Test Computer will prompt user that DTC has been set and to continue. If no pending DTC is set, after 30 s the Test Computer will prompt the user to continue without a pending DTC (logged as a failure).

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	**Data Description**	**Byte Value (Hex)**
Byte 1	PGN of requested message (i.e., DM6 - PGN = 65231, 0x00FECF)	CF
Byte 2		FE
Byte 3		00

Figure 22 - Pending emission related DTCs (DM6) request message

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

Figure 23 - ECU#x response: pending emission related DTCs (DM6) response message

Evaluation criteria:

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

7.5 Verify DM25 – request expanded freeze frame (DM25) data

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

Procedure:

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

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	**Data Description**	**Byte Value (Hex)**
Byte 1	PGN of requested message (i.e., DM25 - PGN = 64951, 0x00FDB7)	B7
Byte 2		FD
Byte 3		00

Figure 24 - Freeze frame data (DM25) request message

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

Figure 25 - ECU#x response: freeze frame (DM25) response message

Evaluation criteria:

- If at least one ECU complying with OBD level of CCR1971.1 does not support DM25, this shall be flagged as a failure.
- For each ECM that supports DM25, verify the Freeze Frame length(s) correctly correspond with the length of the Data field. If the Freeze Frame length and Data field length do not correspond correctly, then this shall be flagged as a failure.

7.6 Verify DM4 – request freeze frame data, engine running

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

7.6.1 Standard freeze frame

Procedure:

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

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	0 (Engine), other OBD compliant ECUs	
Data:	**Data Description**	**Byte Value (Hex)**
Byte 1	PGN of requested message (i.e., DM4 - PGN = 65229, 0x00FECD)	CD
Byte 2		FE
Byte 3		00

Figure 26 - Freeze frame data (DM4) request message

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

Figure 27 - ECU#x response: freeze frame (DM4) response message

Evaluation criteria:

- If an ECU does not support DM4, it shall respond with a NACK to a DM4 request instead of the Figure 27 data bytes.
- If an ECU supports DM4 but has no accumulated freeze frames to report, it shall respond with a DM4 message with 0x00 in byte 1, 0x00 in bytes 2 through 5 and 0xFF in bytes 6 through 8.
- Freeze frame may be stored when pending DTC is set; however, it is not required. If freeze frame is not stored for pending codes, byte 1 of the DM4 message is reported as 0x00 for each ECU response. If this is the case, skip the remainder of Section 7.6.
- If freeze frame is supported for pending codes, verify that a Freeze Frame DTC in the DM4 messages is the same as one of the DTCs reported in DM6 for the ECU.