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Superseding J1939-84 OCT2017

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

RATIONALE

This version of SAE J1939-84 adds support for SI engines in the text and Appendix A. Appendix A tables are renumbered sequentially. Parameters specific to SI engines have been added to Table A2, and implausible value criteria have been improved. Table A2 has also been improved for non-OBD modules that support battery voltage, fuel level, and Component ID. Table A14 has been updated to show the two-byte slots added since the last publication.

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 is 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 SAE Recommended Practice is to verify that vehicles and/or components are capable of communicating a required set of information, which is described by the diagnostic messages specified in SAE J1939-73, that is in accordance with 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 U.S. 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 Tables 1 and 2 for OBD compliance support, and the discussion in SAE J1939-73 Appendix H for additional implementation concepts.

2. REFERENCES

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

2.1 Applicable Documents

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

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +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, 250 Kbps, Twisted Shielded Pair
SAE J1939-13	Off-Board Diagnostic Connector
SAE J1939-14	Physical Layer, 500 Kbps
SAE J1939-15	Physical Layer, 250 Kbps, 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: Refer to SAE J1939-73 Section 2 and Table 2 for a full list of ARB, European, and U.S. EPA OBD regulations supported by SAE J1939-73, including 13 CCR 1968.1.

2.1.3   Code of Federal Regulations (CFR) Publications

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

49 CFR Part 565   Subpart B, VIN Requirements

2.1.4   U.S. EPA Publications

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

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," U.S. EPA, 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

NOTE: SAE J1699-3 is a registered trademark of SAE International.

2.2.2   ISO Publications

Copies of these documents are available online at https://webstore.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) Publications

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 may be flagged using the word "WARNING" for further analysis by the test computer operator. Some warning criteria in Section 6 tests are informative only; the word "INFO" is used instead of the word "Warning" in such cases.

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

3.2   Acronyms

The following are common acronyms used in this document:

ARB	Air Resources Board
CAL ID	Calibration Identification
CAN	Controller Area Network
CCM	Comprehensive Component Monitoring
CI	Compression Ignition
CVN	Calibration Verification Number
DM	Diagnostic Message
DTC	Diagnostic Trouble Code
ECM	Engine Control Module
ECU	Electronic Control Unit
EI-AECD	Emissions Increasing - Auxiliary Emissions Control Device
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

MY   Model Year

NVRAM   Non-Volatile Random Access Memory

OBD II   On Board Diagnostics (Level 2)

PG   Parameter Group

PGN   Parameter Group Number

PVE   Production Vehicle Evaluation

RPM   Revolutions per Minute (min^{-1})

SP   Suspect Parameter

SPN   Suspect Parameter Number

SA   Source Address (refer to SAE J1939-21)

SCC   Since Code Clear

SI   Spark Ignition

TID   Test Identifier (refer to 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, SAE J1939-71, SAE 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. 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 should 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 an 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 RP1210B for their SAE J1939 interfaces for diagnostic communications, use of an RP1210C API for PVE testing is highly desirable.
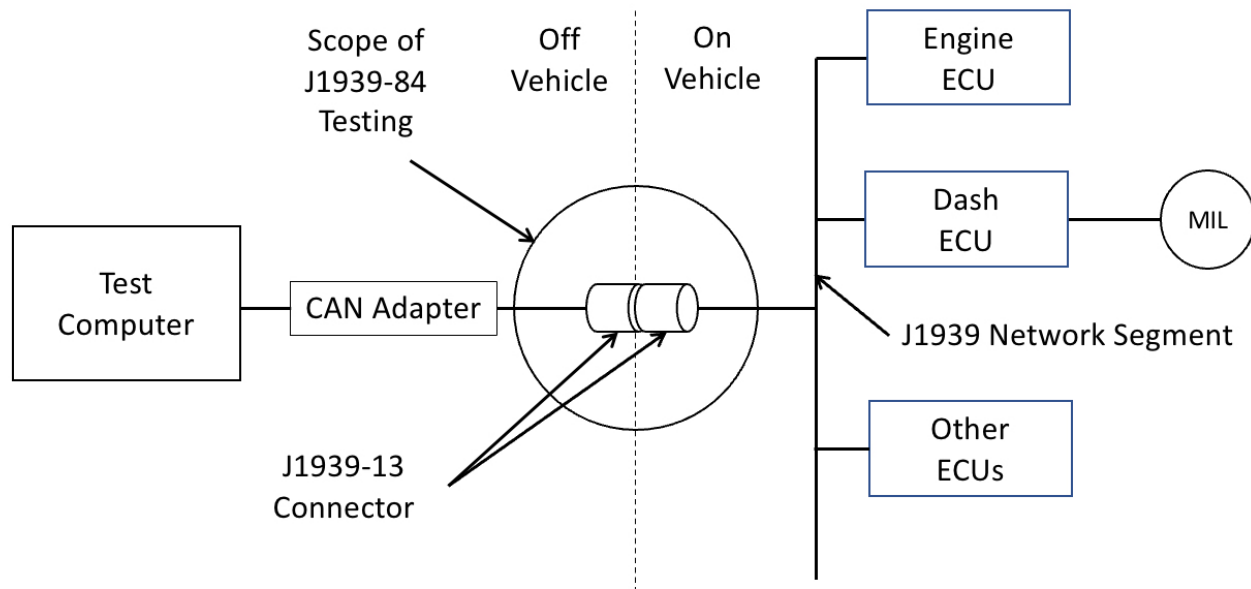
Figure 1 SAE J1939-84 test scope overview

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 shall 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 shall 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 shall provide clear instructions for initiating the fault and its subsequent repair. For Section 7, engine manufacturers shall also identify an SPN, FMI, and test identification combination that provides an example of test results for a completed OBD diagnostic test—these test results shall be available from an engine operating at its normal low idle speed. Finally, engine manufacturers shall 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 can 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 (I)(1). Section 7 provides test procedures for Euro IV and Euro V vehicle testing.

5.   TEST CONDITIONS, TEST PLANNING, AND COMMUNICATION CAPABILITIES

This section discusses common test conditions for the vehicle, 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 can be particularly true of a recently produced vehicle where faults were cleared from each system by end of line processing. These non-OBD ECUs can 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 shall provide responses to DM1 and DM2 as discussed in Section 6. Some incomplete vehicles can 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 °C and 35 °C. Tests shall begin with a well charged battery. If the battery voltage falls below 12 V (or 24 V for a 24-V system), the battery system shall be recharged before testing continues. Test conditions other than those described in SAE J1939-73 5.2.3 can lead to unexpected results.

Formal testing shall be conducted with the test equipment connected via the vehicle's SAE J1939-13 diagnostic connector. Vehicle manufacturer and component manufacturer tools shall not be used in parallel with SAE J1939-84 test equipment. While such tools are helpful to determine whether the vehicle is ready to test, any parallel queries provided can lead to failed SAE J1939-84 test results. Likewise, CAN network analysis tools shall not provide any additional queries when they are used to record all the message traffic for analysis.

5.3   Test Planning

The engine manufacturer and vehicle manufacturer shall agree on the test plan for the vehicle. This test plan shall 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)?

    ○ Section 6 requires two faults with distinct DTCs to demonstrate Mil_Status, pending DTCs, freeze frame content, permanent fault erasure and the general denominator. The first fault used in Section 6 requires that a method induces a two trip, continuous component monitoring fault. The second fault used in Section 6 may be either a one trip, or a two trip, continuous component monitoring fault. See Figure 2 in Section 6 for the timing of individual faults.The process in Section 6 requires that a method induces at least one two trip continuous monitoring fault.

    ○ Section 7 assumes that its method induces a single trip continuous component monitoring fault.

    ○ The sensors used by the failure implant method should be readily accessible for the test technician to disconnect, In addition faults should be detected as failures within an efficient time frame and not require vehicle movement.[1] The recommended method shall support operating cycle counting without vehicle movement.

    ○ The failure maturation time and OBD ECU's operating profile needed to detect the fault shall be documented for the test. produced by the recommendation and recognize its drive cycle shall be documented for the test. Only one DTC should be reported for an implanted fault, because the evaluation criteria assume that one DTC and one freeze frame are the expected outcomes of implanted failures.

- 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? To avoid an unexpected shutdown, what are the preferred settings for an engine idle shutdown feature?

- 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 can 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 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 remains 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 shall be evaluated besides SA 0, function 0 (engine). Section 6.13 discusses additional tailoring considerations for the HD OBD test procedure.

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[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 can be adapted to earlier regulatory versions by omitting requests for SAE J1939-73 diagnostic messages and SAE J1939-71 application layer data that are not required by the earlier versions of the regulation. Careful analysis is required to complete such an adaptation. Tables 1 and 2 of SAE J1939-73 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 should be conducted on a production vehicle containing no faults. The test equipment shall be connected via the SAE J1939-13 diagnostic connector. When tests are conducted on vehicles with faults (or emissions-related pending faults), test results shall be interpreted with care to assure that the failure conditions do not impact the results. Additional faults increase the number of DTCs contained in results, require a search for the expected DTC among them, and fail the evaluation of fault counts. 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 are not 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 RP1210C.

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 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.
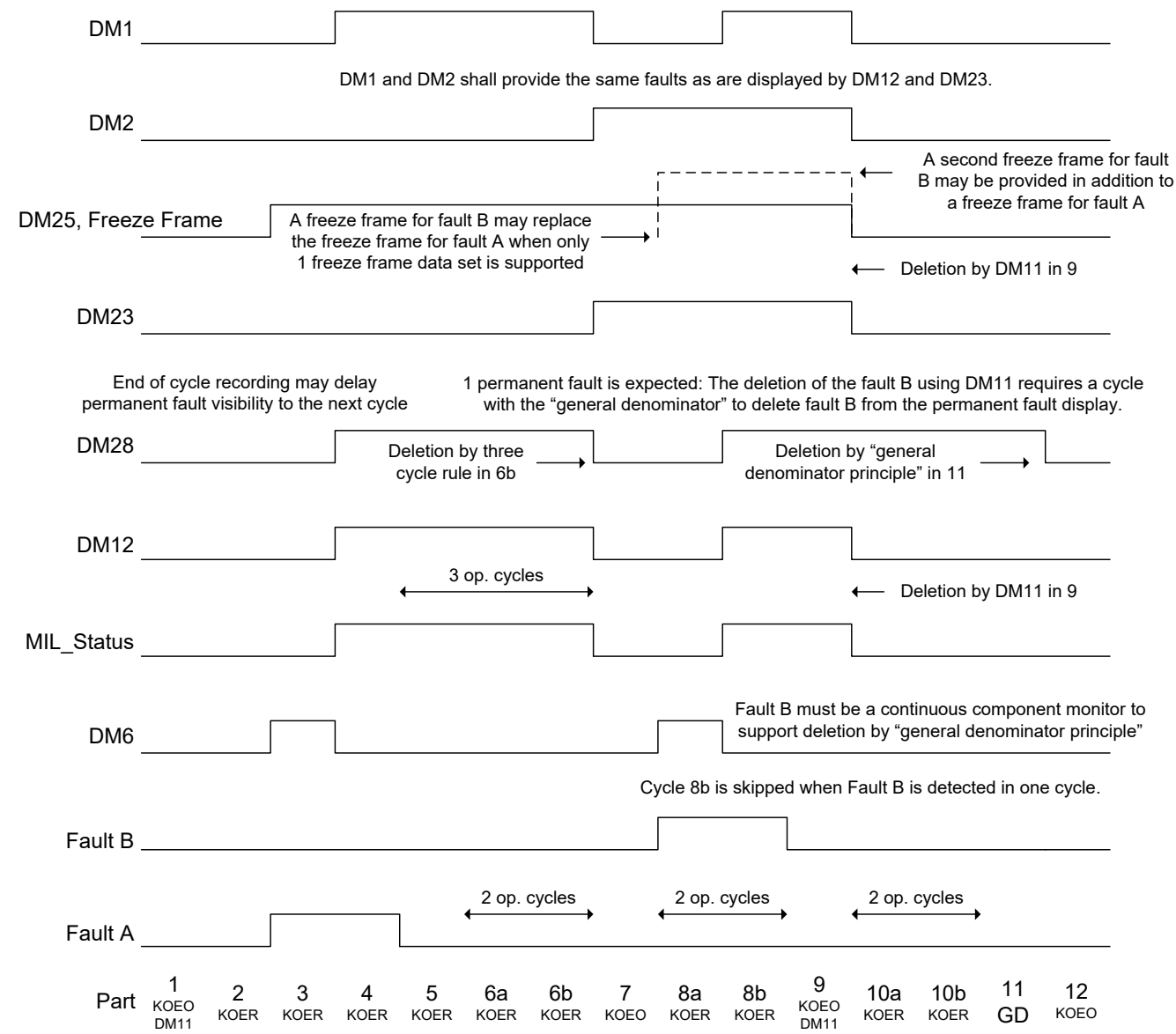
Figure 2 - SAE J1939-84 test process overview

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 12 test parts for PVE testing, explaining the test objectives for each part. These test parts are provided in 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 are easy to disconnect while the engine is off to provide the two-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 should not be seen in DM6 as pending faults shall be deleted within 10 seconds 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 three-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 shall match the DTC displayed in prior DM6 and DM12 displays. The three-cycle rule shall have deleted the permanent fault.
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 shall still be reported using DM28.

Test Part	Test Part Objectives	Test Part Summary
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 shall 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. 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 resources for destination specific responses, 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 are typically 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.[2]

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2   Implementors are encouraged to detect overlapping queries created by on-board devices using the test tool's F9h address. Notices to the user through the implementor's user interface, and messages in the test log of these occurrences are recommended.

C. SAE J1939-73 limits the use of request queries for some multi-packet data and DM7 queries to destination specific addressing.[3] 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, from the query to the first frame of the response, whether provided as a single frame response, BAM, RTS frame, or ACK(Busy).[4] 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 PG control byte value of 3 "Busy" can 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 four 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 1.2 second overall timeout provision shall be accepted with no warning or failure message. Data that is not received shall 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 SP, the test shall pass if the SPN is provided as FFh, or Not Available, as defined in SAE J1939-71 Section 5.

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 PG with a control byte value of 1 (not acknowledgement) is not an automatic disqualification for a given query. Partitioned systems feature ECUs that do not support many of the queried SAE J1939-73 messages. These ECUs should send an Acknowledgment PG control byte value of 1 for those required PGs 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 PG, such ECUs do not respond to the global form of Request for that PG. See Section A.10 for an example set of evaluation criteria.

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[3]   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.

[4]   Contention between long DM1 messages, which are sent with a fixed 1 Hz period, and Long BAM responses to global queries, including DM19, DM20, and Component ID, have been observed. This contention creates race conditions between the global query and the start of the DM1 broadcast (and its completion). Reception of replies sent by the ECM is expected of the test software, when contention occurs.

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 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 V.)

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 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.

    iii. MY of engine,

    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),[5] and

    vi.   Certification intent (U.S., Euro, etc.).

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 the engine speed is greater than 0 RPM, prompt/warn operator to confirm engine is not running.

---

[5]   The number provided by the user shall 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.

6.1.3   DM5: Diagnostic Readiness 1[6]

6.1.3.1   Actions[7]

a. Global[8] DM5 [send Request (PGN 59904) using PGN 65230 (OBD Compliance, SPN 1220)].

b. Create "OBD ECU"[9] list (comprised of all ECUs that indicate 13h, 14h, 22h, or 23h 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 (to DM5, PGN 65230 request).

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 13h and another reports 22h, if one reports 13h and another reports 11h, or if one ECU reports 00h and another reports 14h).

6.1.4   DM24: SPN Support

6.1.4.1   Actions

a. Destination Specific (DS) DM24 [send Request (PGN 59904) using PGN 64950 (SPNs 3297, 4100 to 4103)] to each OBD ECU.[10]

b. If no response [transport protocol RTS or NACK(Busy) in 220 ms], then retry DS DM24 request to the OBD ECU. (Do not attempt retry for NACKs that indicate not supported.)

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

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

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

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[6] The plurality of part 1 responses is used in part 2 warning and failure criteria. See part 2 criteria for specific details. OBD ECUs are expected to respond to the same queries when the engine is running, as when the key is on and the engine is off. The data constants in DM24, DM34, DM56 and Component ID are not expected to change, and criteria compare the complete part 1 and part 2 responses. DM20 is checked for changes in monitor identity labels, and DM7 is checked for test results labels. Test criteria is also provided for data that is expected to monotonically increase during the test. Other parts check for inappropriate erasure of test results and other OBD data as discussed in appendix section A-5. Implementation designs shall account for the reuse of earlier responses in later criteria.

[7] Not all forward references for reused data are noted where they are queried.

[8] 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 6.1 for more information about ACKs and NACKs and other referenced requirements given in SAE J1939-21.

[9] "OBD ECU" means an ECU reporting 13h (19), 14h (20), 22h (34), or 23h (35) for OBD compliance in DM5. Devices that respond with 05h or FFh imply that they are not intended to comply with HD OBD requirements. Treat devices that return 0 as not an OBD ECU, and ensure that the warning message for mismatched values is provided as the outcome for 6.1.3.3. Always warn if a response from a non-OBD ECU is being used/received/evaluated anytime in test, unless directed otherwise by Table A2 or the detailed actions and criteria. For example, see Component ID queries in 6.1.9.4.

[10] Timeout provisions for this and other RTS/CTS transport protocol responses shall follow SAE J1939-21 Figure C1.

6.1.4.2   Fail Criteria[11]

a.   Fail if retry was required to obtain the DM24 response.

b.   Fail if one or more minimum expected SPNs for data stream not supported per Section A.1 from the OBD ECU(s).

c.   Fail if one or more minimum expected SPNs for freeze frame not supported per Section A.2 from the OBD ECU(s).

6.1.5   VIN Verification (Vehicle Id, PGN 65260, (VIN, SPN 237))

6.1.5.1   Actions

a.   Global Vehicle Id [send Request (PGN 59904) using PGN 65260 (VIN, SPN 237)].[12]

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.[13]

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) using PGN 64711 (SPNs 5844 and 5845)).

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[11]   Failure criteria for data stream support in distributed systems shall consider the system's overall response. No one module can be expected to provide all the required data in a distributed implementation. For example, when an SPN is listed as supported for a freeze frame or a test result, it cannot be assumed that the very same module shall support the communication of the data in an SAE J1939-73 or SAE J1939DA PG. The communication of the data is a system requirement and cannot be assumed to be provided by the same module saving the freeze frame with the SPN or providing test results for a given SPN. Minimum test result coverage is assessed in step 6.1.11 according to Section A.7.

[12]   The use of global requests in tests requires a capable data link adapter to be able to handle multiple transport sessions. Additionally, the global response takes a fair amount of time due to packet separation requirements (50 to 200 ms separation).

[13]   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.

6.1.6.2   Fail Criteria (if supported)[14]

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 (first digit) does not match user MY input.[15]

e.   Fail if engine family isn't exactly 12 characters before first asterisk character (ASCII 2Ah) or "null" character (ASCII 00h).

6.1.7   DM19: Calibration Information

6.1.7.1   Actions

a.   Global DM19 [send Request (PGN 59904) using PGN 54016 (SPNs 1634 and 1635)].

b.   Create list of the received ECU addresses, CAL IDs, and CVNs. (An ECU address can report more than one CAL ID and CVN.)

c.   Display this list in the log. (NOTE: Display the CVNs using big endian format and not little endian format as given in the response.)

6.1.7.2   Fail Criteria

a.   Fail if total number of reported CAL IDs is less than the 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 every CAL ID doesn't have exactly one CVN.

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

   iii. Fail if any received CAL ID is all FFh or any CVN is all 00h.

   iv.   Fail if CVN padded incorrectly (padding shall use 00h in MSB for unused bytes).

---

[14]   "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 all, one or more than one OBD 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.

[15]   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 U.S. EPA at http://iaspub.epa.gov/otaqpub/publist_gl.jsp?guideyear=2007.

6.1.7.3   Warn Criteria

a.   Warn if total number of reported CAL IDs is greater than the 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 every CAL ID doesn't have exactly one CVN.

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

    iv.   Warn if any received CAL ID is all FFh or any CVN is all 00h.

    v.   Warn if CVN padded incorrectly (shall use 00h 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.[16]

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

6.1.8   DM20: Monitor Performance Ratio

6.1.8.1   Actions

a.   Global DM20 (send Request (PGN 59904) using PGN 49664 (SPNs 3048, 3049, 3066 to 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. When a numerator and denominator are provided as FFFFh and FFFFh, the monitor identified in the label SPN shall be considered to be unsupported.

6.1.9   Component ID: Make, Model, Serial Number Support

6.1.9.1   Actions

a.   Destination Specific (DS) Component ID [send Request (PGN 59904) using PGN 65259 (SPNs 586, 587, and 588)] to each OBD ECU.

b.   Display each positive return in the log.

---

[16]   13 CCR 1971.1 (h)(4.7.5) allows for delayed timing during the first 120 seconds of operation after memory has been "reprogrammed." This procedure assumes that the allowed 120 seconds has already expired.

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 5 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.[17]

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 eight characters long.

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

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

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

6.1.9.4   Actions2

(NOTE: No warning message shall be provided for responses from non-OBD devices using PGN 59904.)[18]

a.   Global Component ID [send Request (PGN 59904) using PGN 65259 (SPNs 586, 587, and 588)].

b.   Display each positive return in the log.

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, when supported by destination specific query.

6.1.10   DM11: Diagnostic Data Clear/Reset for Active DTCs

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[17] Unprintable ASCII characters include those characters [numerically] less than ASCII 20 (space).
[18] Warnings for non-OBD device responses shall not be issued for Component ID. Component ID provides a template to identify make, model, and serial number of any major component or subsystem installed in a vehicle. Warn only based on the criteria in 6.1.9.6.

6.1.10.1   Actions

a.   Global DM11 [send Request (PGN 59904) using PGN 65235].

b.   Allow 5 seconds to elapse before proceeding with test step 6.1.10.2.

c.   Pass, if no response to the global DM11 query has been received in 5 seconds.

d.   Record all ACK/NACK/BUSY/Access Denied responses (for PGN 65235) in the log.[19]

6.1.10.2   Fail Criteria

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

6.1.10.3   Warn Criteria

a.   Warn if ACK received from any HD OBD ECU.[20]

6.1.11   DM21: Diagnostic Readiness 2

6.1.11.1   Actions

a.   Global DM21 [send Request (PGN 59904) using 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).[21]

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

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

6.1.11.3   Actions2

a.   DS DM21 to each OBD ECU.

---

[19] Only the Acknowledgment PG can be sent in replies, since DM11 is a command assignment with no SPs defined to send in the CAN frame data. DM3 works the same way.
[20] 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.
[21] When "if supported" is indicated for a given SP 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. Refer to SAE J1939-71 for presentation layer conventions in SP data.

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) greater than 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.[22]

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 a list of ECU address and SPN and FMI supported test results.[23]

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) using PGN 65230 (SPNs 1218 to 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 no OBD ECU reports DTC counts of 0 for both active and previously active faults.

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.

---

[22] An ECU that does not support a given PGN should 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.

[23] 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) using PGN 64952 (SPNs 3301 to 3305)].[24]

    i.   Create list by OBD 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 to 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 also reported in DM26 as "1, monitor not complete this monitoring cycle" in SPN 3303 bits 5 to 7.

c.   Fail if any response for each monitor not supported in DM5 by a given ECU is also reported in DM26 as "0, monitor enabled for this monitoring cycle" in SPN 3303 bits 1 and 2 and SPN 3304.

d.   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.[25]

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

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

g.   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.

---

[24] The conventions used to describe queries as in, "Global DM26 [send Request (PGN 59904) using PGN 64952 (SPNs 3301 - 3305)]", says that the query sent to the vehicle shall be the global form of the J1939-21 Request PG for the DM26 (PG 64952) message. "SPNs 3301 - 3305" identifies SPNs that are used in the subsequent evaluation criteria for vehicle responses. Destination Specific (DS) addressing with the Request PG shall be used for forms like "DS DM26 [send Request (PGN 59904) using PGN 64952 (SPNs 3301 - 3305)]" Destination Specific forms are followed by a description of the ECUs to be individually queried, by using their Source Addresses in the Destination Address field for the SAE J1939-21 Request Message.

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

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 to 1215, 1706, and 3038)].

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.[26]

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 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 (00b, 00b).

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) using PGN 65227 (SPNs 1213 to 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.

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

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[26]   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   DM6: Emission Related Pending DTCs

6.1.17.1   Actions

a.   Global DM6 [send Request (PGN 59904) using PGN 65227 (SPNs 1213 to 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.

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) using PGN 65236 (SPNs 1213 to 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) using PGN 64949 (SPNs 1213 to 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) using PGN 64896 (SPNs 1213 to 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) using PGN 64898 (SPNs 1213 to 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) using PGN 40448 (SPNs 4104 to 4108)].

6.1.22.2   Fail Criteria

a.   For ECUs that support DM27, fail if any ECU does not report counts of 0 for pending DTCs, all pending DTCs, MIL on DTCs, previous MIL on DTCs, and permanent DTCs.[27]

b.   For ECUs that do not support DM27, fail if any ECU does not report counts of 0 for pending DTCs, MIL on DTCs, previous MIL on DTCs, permanent DTCs, and a value of FFh all pending DTCs.

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) using 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) using PGN 64951 (SPNs 3300, 1214, 1215)] to each OBD ECU that responded to DS DM24 with supported freeze frame SPNs.

---

[27] 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 FFh 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 FFh for SPN 4105 in a DM29 response.

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 to 5 = 00h and bytes 6 to 8 = FFh).

6.1.25   DM20: Monitor Performance Ratio

6.1.25.1   Actions

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

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

b.   If no response [transport protocol RTS or NACK(Busy) in 220 ms], then retry DS DM20 request to the OBD ECU. (Do not attempt retry for NACKs that indicate not supported.)

6.1.25.2   Fail Criteria

a.   Fail if retry was required to obtain DM20 response.

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

c.   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.   Create a list of expected SPNs and PGNs from the DM24 response, where the data stream support bit defined in SAE J1939-73 5.7.24 is 0. Omit the following SPNs (588, 976, 1213, 1220, 12675, 12730, 12783, 12797) which are included in the list. Omit any remaining SPNs that map to multiple PGs. Display the completed list noting those omitted SPNs and supported SPNs as "broadcast" or "upon request."

b.   Gather broadcast data for all SPNs that are supported for data stream in the OBD ECU DM24 responses.

c.   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 by the OBD ECU in DM24.[28]

b.　Fail if any parameter is not broadcast within ±10% of the specified broadcast period.[29]

c.　Fail/warn if any broadcast data is not valid for KOEO conditions as per Table A2, Minimum Data Stream Support.[30]

d.　Fail/warn per Table A2 if an expected SPN from the DM24 support list is provided by a non-OBD ECU.

e.　Fail/warn per Table A2 if two or more ECUs provide an SPN listed in Table A2.

6.1.26.3　Actions2

a.　Identify SPNs provided in the data stream that are listed in Table A2, but are not supported by any OBD ECU in its DM24 response.

6.1.26.4　Fail/Warn Criteria2

a.　Fail/warn per Table A2 column, "Action if SPN provided but not included in DM24."

6.1.26.5　Actions3

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).

6.1.26.6　Fail/Warn Criteria3 (see footnotes 24 and 25 for a and b, respectively)

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

b.　Fail if any parameter in a fixed period broadcast message is not broadcast within ±10% of the specified broadcast period.

c.　Fail if any parameter in a variable period broadcast message exceeds 110% of its recommended broadcast period.[31]

---

[28]　Missing SPN support, as compared to Table A2, shall be determined for the SPN data presented by DM24 in test 6.1.4. Here only SPs provided in the DM24 data from test 6.1.4 need be evaluated. As given in (d) data from non-OBD ECUs may be flagged with a warning or an informational message. Data that does not meet Table A2 plausibility limits, or that does not meet broadcast period requirements, shall be counted as present (passing), without additional warning or failure messages than those generated for the plausibility limits, provided that it is not sent using the SAE J1939-71 Error (FEh) or Not Available (FFh) Indicators.

[29]　There are potential exceptions to scheduled broadcasts that are allowed implementations.
　　a.　Data may be available on request only for a given network segment. Once requested, it should be broadcast using its expected period, subject to provision in (b). Once on the broadcast schedule, queries may be ignored by the ECU and may be perceived to be timed out vs. Tr = 220 ms. But, they would not be timed out vs Tr = 1200 ms.
　　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.　The need to send multiple BAM messages in a single second can disrupt timing by more than 10%.
　　These exceptions need not be automated in initial data analyses provided by the test tool.

[30]　Broadcast data that does not meet plausibility values shall not result in a determination that the data is not supported as is required by the SPN column. The warning for invalid values shall suffice as the test outcome. Where the plausibility value is listed as N/A, only the reception of FFFFh shall be considered a failure for not supporting the required data. Received values of the error indicator (e.g. FE00h), shall be considered a plausibility failure and not a non-support failure. With this understanding, broadcast data that does not meet the plausibility values need not be queried, as if they are noted as an on request parameter.

[31]　Messages that depend on engine speed and other variable period messages shall fail only if the engine's broadcast period exceeds the messages' recommended (fixed) broadcast period by more than 10%. Some SPNs are defined to be broadcast on change, but no more frequently than a fixed rate. Message reception periods that are less than 90% of the fixed broadcast period shall not fail for engine speed dependent and other variable period messages.

d. Fail/warn if any broadcast data is not valid for KOEO conditions as per Section A.1 Table A2, Minimum Data Stream Support.

e. Warn/info per Table A2 if an expected SPN from the DM24 support list is provided by a non-OBD ECU.

f. Fail/warn per Table A2 if two or more ECUs provide an SPN listed in Table A2.

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.

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 1 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 the engine speed is less than 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) using PGN 65230 (SPNs 1218 to 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.[32]

b. Fail if no OBD ECU reports active/previously active fault DTC count = 0/0.

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

---

[32] 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 shall be allowed with the engine running. Section A.6 discusses the resulting engine running evaluation further.

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.

6.2.3   DM24: SPN Support

6.2.3.1   Actions

a.   DS DM24 [send Request (PGN 59904) using PGN 64950 (SPNs 3297, 4100 to 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.[33]

6.2.4   DM20: Monitor Performance Ratio

6.2.4.1   Actions

a.   Global DM20 [send Request (PGN 59904) using PGN 49664 (SPNs 3048 to 3049, 3066 to 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) using PGN 54016 (SPNs 1634 to 1635)] to all ECUs that responded to global DM19 in part 1.

---

[33]   This can be accomplished with a comparison to the responses received in part 1. The order of SPNs shall remain constant as DM24 defines a fixed format record layout for the freeze frame content in DM25.

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.[34]

6.2.6   DM56: Model Year and Certification Engine Family

6.2.6.1   Actions

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

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) using 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

(NOTE: No warning message shall be provided for responses from non-OBD devices using PGN 59904.)

a.   Global Request for Component ID request (PGN 59904) using 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.

---

[34]   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. (The most Important CAL ID shall be first.)

6.2.8   DM26: Diagnostic Readiness 3

6.2.8.1   Actions

a.   DS DM26 [send Request (PGN 59904) using PGN 64952 (SPNs 3301 to 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.[35]

c.   Fail if NACK not received from OBD ECUs that did not provide a DM26 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., $T_2 - T_1$ <= SPN 3301 response data value <= $T_2 - T_1$ + 1 second.

6.2.9   DM21: Diagnostic Readiness 2

6.2.9.1   Actions

a.   Global DM21 [send Request (PGN 59904) using PGN 49408 (SPNs 3069, 3294 to 3296)].

6.2.9.2   Fail Criteria

a.   Fail if any ECU reports a distance greater than 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 a time greater than 0 for time (if supported) or distance with MIL on.

d.   Fail if any ECU reports a time equal to zero in Time SCC (SPN 3296) (if supported).

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

---

[35] 13 CCR 1971.1 (c) (c. 2013) defines a warm-up cycle to require a 40 °F temperature rise in the engine coolant temperature. That is unlikely to occur in the time expected. Therefore, zero is the correct response.

6.2.9.3   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 using 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 12, 6.1.12.[36]

6.2.10.3   Warn Criteria

a.   Warn if all test results show initialized results across all SPNs requested.[37]

6.2.11   DM27: All Pending DTCs

6.2.11.1   Actions

a.   Global DM27 [send Request (PGN 59904) using PGN 64898 (SPNs 1213 to 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.

---

[36] Changes in measurements are expected, changes in the number and content of SPN and FMI combinations are not expected and shall fail if additional SPN and FMI combinations are found, or if any SPN and FMI combinations go missing.

[37] 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 can cause some results to be complete, so it is inappropriate to assume that all tests are still initialized following the DM11 clear faults command in part 1.

6.2.12   DM29: Regulated DTC Counts

6.2.12.1   Actions

a.   Global DM29 [send Request (PGN 59904) using PGN 40448 (SPNs 4104 to 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/FFh/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.

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.[38]

6.2.13   DM31: DTC to Lamp Association

6.2.13.1   Actions

a.   DS DM31 [send Request (PGN 59904) using 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) using 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 to 5 = 00h and bytes 6 to 8 = FFh (no freeze frame data available).

---

[38]   An ECU that does not support a given PGN should 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   DM33: Emission Increasing Auxiliary Emission Control Device Active Time

6.2.15.1   Actions

a.   Global DM33 [send Request (PGN 59904) using PGN 41216 (SPNs 4124 to 4126)].

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

6.2.15.2   Fail Criteria.

[Engines using SI technology need not respond until the 2024 engine model year.][39]

a.   Fail if no ECU responds.

6.2.15.3   Warn Criteria

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

6.2.15.4   Actions2

a.   DS DM33 to each OBD ECU.

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.[40]

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) using PGN 40960 (SPNs 4127 to 4132)].

6.2.16.2   Fail Criteria

a.   Fail if no ECU responds, unless the user selected SI technology.

b.   Fail if any ECU response is not equal to 00b (Outside Control Area) for NOx and PM control areas (byte 1 bits 7 to 8, byte 2 bits 7 to 8).

c.   Fail if any ECU response is not equal to 00b (Outside Area) or 11b (not available) for NOx/PM carve-out/deficiency areas (byte 1 bits 5 to 6 and byte 2 bits 5 to 6).

d.   Fail if any ECU response is not equal to 11b for byte 1 bits 1 to 2 and for byte 2 bits 1 to 2.

e.   Fail if any reserved bytes 3 to 8 are not equal to FFh.

---

[39]   2024 MY SI engines are required to support EI-AECDs and shall fail as well. SI engines are not expected to support DM34 through the 2024 engine model year and beyond.
[40]   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.

6.2.16.3   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 Data Stream Verification

6.2.17.1   Actions

a.   Create a list of expected SPNs and PGNs from the DM24 response, where the data stream support bit defined in SAE J1939-73 5.7.24 is 0. Omit the following SPNs (588, 976, 1213, 1220, 12675, 12730, 12783, 12797) which are included in the list. Omit any remaining SPNs that map to multiple PGs. Display the completed list noting those omitted SPNs and supported SPNs as 'broadcast' or 'upon request'.

b.   Gather broadcast data for all SPNs that are supported for data stream in the OBD ECU DM24 responses.

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

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 Table A2.

c.   Fail/warn per Table A2 if an expected SPN from the DM24 support list is provided by a non-OBD ECU.

d.   Fail/warn per Table A2 if two or more ECUs provide an SPN listed.

6.2.17.3   Actions2

a.   Identify SPNs provided in the data stream that are listed in Table A2, but not supported by any OBD ECU in its DM24 response.

6.2.17.4   Fail/Warn Criteria2

a.   Fail/warn per Table A2 column, "Action if SPN provided but not included in DM24."

6.2.17.5   Actions3

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).

6.2.17.6   Fail/Warn Criteria3

a.   Fail if no response/no valid data for any upon request SPN indicated as supported in DM24, per Table A2.

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[41]. The OBD system should 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 less than 400 RPM, prompt/warn operator to confirm engine is running and then press enter.

6.3.2   DM6: Emission Related Pending DTCs[42]

6.3.2.1   Actions

a.   Global DM6 [send Request (PGN 59904) using PGN 65227 (SPNs 1213 to 1215, 3038, 1706)].

   i.   Repeat request for DM6 no more frequently than once per second 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.

6.3.2.2   Fail Criteria

a.   Fail if no OBD ECU supports DM6.

---

[41]   To best serve this part, the implanted fault should run multiple times per drive cycle and should 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).

[42]   The DM6 response should contain the Fault A DTC. This DTC value shall be used to evaluate subsequent DM27 (if supported), DM25, DM12, DM1, DM23, DM2, and DM28 responses, as shown in the Figure 2 signal chart for the tests that provide the timeline axis. Figure 2 also depicts Fault B and its application to selected DM responses.

6.3.2.3   Warn Criteria

a.   Warn if any ECU reports greater than 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) using PGN 64898 (SPNs 1213 to 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) using PGN 40448 (SPNs 4104 to 4108)].

6.3.4.2   Fail Criteria

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

b.   Fail if no ECU reports a count greater than 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 = FFh.

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 a count greater than 1 for pending or all pending.

b. Warn if more than one ECU reports a count greater than 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) using 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 to 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) using PGN 65227 (SPNs 1213 to 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) using PGN 65230 (SPNs 1218 to 1219)].

6.3.8.2   Fail Criteria

a.   Fail if any OBD ECU does not report counts of zero 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) using PGN 65236 (SPNs 1213 to 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.

6.3.10   DM23: Emission Related Previously Active DTCs

6.3.10.1 Actions

a.   Global DM23 [send Request (PGN 59904) using PGN 64949 (SPNs 1213 to 1215, 3038, 1706)].

6.3.10.2   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.

6.3.10.3   Actions2

a.   DS DM23 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   DM28: Permanent DTCs

6.3.11.1   Actions

a.   Global DM28 [send Request (PGN 59904) using PGN 64896 (SPNs 1213 to 1215, 3038, 1706)].

6.3.11.2   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.

6.3.11.3   Actions2

a.   DS DM28 to each OBD ECU.

6.3.11.4   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.

6.3.12   DM24: SPNs Supported

6.3.12.1   Actions

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

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

6.3.12.2   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.

6.3.13   DM25: Expanded Freeze Frame

6.3.13.1   Actions

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

b.   If no response [transport protocol RTS or NACK(Busy) in 220 ms], then retry DS DM25 request to the OBD ECU. (Do not attempt retry for NACKS that indicate not supported.)

c.   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.

6.3.13.2   Fail/Warn Criteria

a.   Fail if retry was required to obtain DM25 response.

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

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

d.   Fail if freeze frame data does not include the same SPN and FMI as DM6 pending DTC earlier in this part.[43]

e.   Fail/warn per Section A.2.

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

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

6.3.14   DM20: Monitor Performance Ratio

6.3.14.1   Actions

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

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

6.3.15   DM21: Diagnostic Readiness 2

6.3.15.1   Actions

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

6.3.15.2   Fail Criteria

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

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

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[43] Where initial conditions were not well observed, there can 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.

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

6.3.16.1 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.

g. 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 less than 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) using PGN 65236 (SPNs 1213 to 1215, 1706, and 3038)] to retrieve confirmed and active DTCs.

   i. Repeat request no more frequently than once per second 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 and FMI(s) as DM6 pending DTC in part 3.

6.4.2.3   Warn Criteria

a. Warn if any ECU reports greater than 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 to 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) using PGN 65227 (SPNs 1213 to 1215, 1706, and 3038)].

6.4.4.2   Fail Criteria (if supported)

a.   Fail if any OBD ECU reports any 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) using PGN 64949 (SPNs 1213 to 1215, 1706, and 3038)] to each OBD ECU.

6.4.5.2   Fail Criteria

a.   Fail if any ECU reports any 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) using PGN 65230 (SPNs 1218 to 1219)].

6.4.6.2   Fail Criteria

a.   Fail if no OBD ECU reports a number of active DTCs greater than 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 a count greater than 0 previously active DTCs.

6.4.7   DM31: DTC to Lamp Association

6.4.7.1   Actions

a.   DS DM31 [send Request (PGN 59904) using 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) using PGN 65227 (SPNs 1213 to 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) using PGN 64898 (SPNs 1213 to 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) using 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) using 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 one 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 for each DM24 SPN and FMI 31.)

b. Create list of any ECU address, SPN and FMI combination with non-initialized test results, noting the number of initialized test results for each SPN and FMI combination that has 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, 6.1.11.[44]

6.4.13 DM3: Diagnostic Data Clear/Reset for Previously Active DTCs

6.4.13.1 Actions

a. DS DM3 [send Request (PGN 59904) using PGN 65228] to each OBD ECU.[45]

b. Wait 5 seconds before checking for erased information.

6.4.13.2 Fail Criteria

a. Fail if any OBD ECU does not NACK with control byte = 1 or 2 or 3.

b. if any ECU erases any diagnostic information. See Section A.5 for more information. [46]

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

6.4.13.3 Actions2

a. Global DM3.[47]

b. Wait 5 seconds before checking for erased information.

6.4.13.4 Fail Criteria2

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 and FMI that had non-initialized test results on list created in test 6.4.14.1.

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[44] Changes in measurements are expected, changes in the number and content of SPN and FMI combinations are not expected and shall fail if additional SPN and FMI combinations are found, or if any SPN and FMI combinations go missing.

[45] 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.

[46] 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.

[47] The global DM3 queries shall always be sent, regardless of the OBD ECU response to the DS DM3 queries.

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.

6.4.15   Part 4 to Part 5 Transition - Complete Fault A First 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 first 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 seconds, the engine speed is less than 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) using PGN 65236 (SPNs 1213 to 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 test 6.3.2.[48]

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 to 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) using PGN 64896 (SPNs 1213 to 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) using PGN 40448 (SPNs 4104 to 4108)].

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[48] The DM6 response is expected to provide the Fault A DTC value to be used as the standard for subsequent responses, expecting the DTC value for fault A. Should there be no value for fault A returned in test 6.3.2, the standard value for Fault A shall be considered to be null, and all subsequent comparisons to the null value shall fail.

6.5.5.2   Fail Criteria

a.   Fail if any ECU reports a count greater than 0 for emission-related pending DTCs or previous MIL on DTCs.

b.   Fail if no ECU reports a count greater than 0 for 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 a count greater than 0; for all pending DTCs (SPN 4105).

    ii.   Fail if any ECU reports FFh, 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) = FFh.

6.5.5.3   Warn Criteria

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

b.   Warn if more than one ECU reports greater than 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) using 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 first cycle.

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

c.   Start Engine for second cycle.

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

e.   Turn the engine off to complete the second 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 third 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 seconds, the engine speed is less than 400 RPM, then 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) using PGN 65230 (SPNs 1218 to 1219)].

6.6.2.2   Fail Criteria

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

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

6.6.2.3   Warn Criteria

a.   Warn if any ECU reports a count of greater than 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) using PGN 65236 (SPNs 1213 to 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 to 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) using 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) using PGN 64949 (SPNs 1213 to 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) using PGN 64896 (SPNs 1213 to 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) using PGN 40448 (SPNs 4104 to 4108)] to each OBD ECU.

6.6.8.2　Fail Criteria

a.　Fail if any ECU reports a count greater than 0 for emission-related pending DTCs or previous MIL on DTCs.

b.　Fail if no ECU reports a count greater than 0 for MIL on DTCs.

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

d.　Fail if no ECU reports a count greater than 0 for permanent DTCs

e.　Fail if any ECU reports a different count for permanent DTCs than the number of DTCs 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 = FFh.

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 a count greater than 1 for MIL on DTCs.

b.   Warn if more than one ECU reports a count greater than 0 for MIL on DTCs.

c.   Warn if any ECU reports a count greater than 1 for permanent DTCs.

d.   Warn if more than one ECU reports a count greater than 0 for permanent DTCs..

6.6.9   DM31: DTC to Lamp Association

6.6.9.1   Actions

a.   DS DM31 [send Request (PGN 59904) using 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) using 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 greater than 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 greater than 0 and difference between times reported is greater than 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 for key on to key off transition.

c.   Turn key to on position.

d.   If required by engine manufacturer, start the engine for start to start operating cycle effects.[49]

e.   Otherwise, Proceed with part 7.

f.   Turn engine off.

g.   Wait engine manufacturer's recommended interval for key on to key off transition.

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 three 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 greater than 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) using PGN 64949 (SPNs 1213 to 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.

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[49] Manufacturers shall disclose those implementations which require an engine start to recognize the end of the third operating cycle before they extinguish the MIL, delete the DM12 MIL-on fault, and display the DM23 previous MIL-on fault.

6.7.2.3   Warn Criteria

a.   Warn if any ECU reports greater than 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) using PGN 65227 (SPNs 1213 to 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) using PGN 65236 (SPNs 1213 to 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 to 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) using PGN 65230 (SPNs 1218 to 1219)].

6.7.6.2   Fail Criteria

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

b.   Fail if no OBD ECU reports greater than 0 for previously active DTCs. Ignore previously active count when DM2 is not supported.

c.   Fail if any OBD ECU reports a different number of previously active DTCs than in DM2 response earlier in this Part. Ignore previously active count when DM2 is not supported.

6.7.7   DM6: Emission Related Pending DTCs

6.7.7.1   Actions

a.   Global DM6 [send Request (PGN 59904) using PGN 65227 (SPNs 1213 to 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) using PGN 64898 (SPNs 1213 to 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) using PGN 64896 (SPNs 1213 to 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) using PGN 40448 (SPNs 4104 to 4108)].

6.7.10.2   Fail Criteria

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

b.   Fail if no ECU reports greater than 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 greater than 1 for previous MIL on.

b.   Warn if more than one ECU reports greater than 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) using 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) using 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) using 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) using 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 and FMI 31.

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

b.   Create list of any ECU address and SPN and FMI combination with non-initialized test results.[50]

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[50]   Since multiple test results can be provided for the same SPN and FMI, the number of initialized tests shall be counted for each SPN and FMI pair. Data has been observed where one or more sets of test results (measurements and limits) are observed to remain initialized throughout the set of test conditions offered in a stationary, low-load test. In these cases such tests were not erased: they never ran.

6.7.15.2   Fail Criteria

a.   Fail if any difference in the ECU address and SPN and 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) using PGN 65228].

b.   Wait 5 seconds before checking for erased information.

6.7.16.2   Fail Criteria

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

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 and 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.[51]

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.

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[51]   Since multiple test results can be provided for the same SPN and FMI, newly initialized, or erased, test results shall be evaluated considering a prior known count of the number of initialized test results for a given pairing of SPN and FMI. The SPN and FMI of the "erased" data shall match the SPN and FMI of the DTC with a prior test measurement. See footnote 41.

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 shall 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 two 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 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 seconds the engine speed is less than 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) using PGN 65236 (SPNs 1213 to 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 greater than 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 to 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) using PGN 64949 (SPNs 1213 to 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) using PGN 65227 (SPNs 1213 to 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) using PGN 65230 (SPNs 1218 to 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. Ignore previously active count when DM2 is not supported.

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) using PGN 64896 (SPNs 1213 to 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) using PGN 40448 (SPNs 4104 to 4108)].

6.8.8.2   Fail Criteria

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

b.   Fail if no ECU reports greater than 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 greater than 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 a count greater than 0 for permanent DTCs..

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 a count greater than 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 = FFh.

6.8.8.3   Warn Criteria

a.   Warn if any ECU reports greater than 1 for MIL on.

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

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

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

e.   Warn if any ECU report greater than 1 for permanent.

f.   Warn if more than one ECU reports a count greater than 0 for permanent DTCs..

6.8.9   DM31: DTC to Lamp Association

6.8.9.1   Actions

a.   Global DM31 [send Request (PGN 59904) using 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) using PGN 64951 (SPNs 3300, 1214, 1215)] to each OBD ECU.

6.8.10.2   Fail Criteria

a.   Fail if DTC(s) reported in the freeze frame does not include either the DTC reported in DM12 or the DTC reported in DM23 earlier in this part.

b.   Fail if no OBD ECU provides freeze frame data (i.e. an empty freeze frame is provided by all OBD modules).

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

6.8.10.3   Warn Criteria

a.   Warn if DTC reported by DM23 earlier in this part is not present in the freeze frame data. [52]

6.8.11   DM7/DM30: Command Non-Continuously Monitored Test/Scaled Test Results

6.8.11.1   Actions

a.   Iterate DS DM7 with TID 247, SPN and FMI 31 to OBD ECUs for each SPN in the OBD ECU DM24 response that supports test results.

b.   Create list of uninitialized test results by ECU address, SPN and FMI for each ECU with uninitialized test results. [53]

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 5.7.22).

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

c.   Fail if the ECU provides CLR_ACT_NACK or CLR_PA_NACK with an acknowledgement code greater than 0. [54]

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[52] It is not expected that the Fault B DTC will displace the Fault A DTC in the freeze frame contents for those ECUs that only support one freeze frame, unless Fault B is a misfire or fuel system fault. More than one freeze frame can be reported in a single response.

[53] Since multiple test results can be provided for the same SPN and FMI, this shall be evaluated considering a count of the number of initialized test results for a given pairing of SPN and FMI. Data has been observed where one or more sets of test results (measurements and limits) are observed to remain initialized throughout the set of test conditions offered in a stationary, low-load test.

[54] DM22 as described in SAE J1939-73 5.7.22 is a request that provides its own acknowledgement mechanism, which is given in the control byte value. Acknowledgement code values 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 should produce no response whatsoever. An informative warning is provided in this case.

6.8.12.3   Warn Criteria

a.   Info: if DM22 (PGN 49920) CLR_PA_NACK or CLR_ACT_NACK is not received with an acknowledgement code of 0.[55]

b.   Info: if J1939-21 NACK using 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 using 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) CLR_PA_NACK or CLR_ACT_NACK is not received with an acknowledgement code of 0.

b.   Warn if J1939-21 NACK using 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 using 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.

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[55]   For those ECUs that do not support DM22, no response what-so-ever is a likely occurrence as described in SAE J1939-73 5.7.22. While NACK may not be the preferred response, NACK does provide a positive indication of non-support. Hence, these particular warning messages in 6.8.12.3, 6.8.12.6, 6,9.3.3, and 6.9.3.6 by themselves do not indicate any need for software change in the subject HD OBD ECU. This is indicated by the word "Info" in the criteria. The word INFO: shall be used in test logs instead of the words "warning" or "WARN."

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 using 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.[56]

6.8.13   DM3: Diagnostic Data Clear/Reset for Previously Active DTCs

6.8.13.1   Actions

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

b.   Wait 5 seconds before checking for erased information.

6.8.13.2   Fail Criteria

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

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 and FMI combination, 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.[57]

6.8.15   DM26: Diagnostic Readiness 3

6.8.15.1   Actions

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

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

---

[56] 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. See footnote 43 for erased test results.

[57] When tests have multiple test results for the same SPN and FMI, an increase in the count of initialized test results shall be used to define evidence of a newly erased test. The SPN and FMI of the erased test shall match when checking for the erased results of a particular combination of SPN and FMI.

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 the engine speed is greater than 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) using PGN 65236 (SPNs 1213 to 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 shall 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 greater than 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 5.7.22).

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

c. Fail if the ECU provides CLR_ACT_NACK or CLR_PA_NACK with an acknowledgement code greater than 0.[58]

6.9.3.3   Warn Criteria

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

b. Warn if J1939-21 NACK using 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 using 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) CLR_PA_NACK or CLR_ACT_NACK is not received with an acknowledgement code of 0.

b. Warn if J1939-21 NACK using 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 using PGN 49920.

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

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[58] 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.

6.9.3.9   Actions4

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

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 using 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.[59]

6.9.4   DM20: Monitor Performance Ratio

6.9.4.1   Actions

a.   Global DM20 [send Request (PGN 59904) using PGN 49664 (SPNs 3048 to 3049, 3066 to 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) using 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) greater than 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 greater than 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 and 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 FB00h/FFFFh/FFFFh or 0000h/0000h/0000h for result/min/max).[60]

---

[59] 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.

[60] When tests have multiple test results for the same combination of SPN and FMI, an increase in the count of initialized test results shall be used to define evidence of a newly erased test.

6.9.7   DM33: Emission Increasing Auxiliary Emission Control Device Active Time

6.9.7.1   Actions

a.   Global DM33 [send Request (PGN 59904) using PGN 41216 (SPNs 4124 to 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. [Engines using SI technology need not respond until the 2024 engine model year].

6.9.8   DM11: Diagnostic Data Clear/Reset for Active DTCs

6.9.8.1   Actions

a.   DS DM11 [send Request (PGN 59904) using PGN 65235] to each OBD ECU without DM12 active MIL on DTC, based on the list created in step 6.9.2.1.[61]

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) using PGN 65235].

b.   Wait 5 seconds before checking for erased data.

---

[61] There may be no OBD ECUs that meet this criterion for monolithic designs or diagnostic gateways. When there is more than one ECU in this category, the destination specific requests to individual ECUs can overlap. They shall 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.   Info: 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) using PGN 49408 (SPNs 3295 to 3296)] to each OBD ECU.

6.9.9.2   Fail Criteria

a.   Fail if any report time SCC (SPN 3296) greater than 0 (if supported).

b.   Fail if any report time with MIL on (SPN 3295) greater than 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.   Iterate a DS DM7 request with TID 250 for each (unique) SPN and FMI from the list received in part 1 to the OBD ECU that supports the SPN with test results in its DM24 response.

b.   If the response for the TID 250 query is NACK (control byte = 1), then send DS DM7, for the SPN using TID 247 and FMI 31 to obtain all test results for the SPN. [Item b. will be performed for all SPNs where TID 250 is not supported by the OBD ECU.]

6.9.10.2   Fail Criteria

a.   Fail if any test result received is not initialized. [i.e. does not display FB00h/FFFFh/FFFFh or 0000h/0000h/0000h].

b.   Fail if any difference in what ECU+SPN and FMI combinations have test results compared to the combinations identified in part 1 as having test results.

c.   Fail each SPN exercised, where there is no response for TID 250 and TID 247 queries.

6.9.11   DM20: Monitor Performance Ratio

6.9.11.1   Actions

a.   DS DM20 [send Request (PGN 59904) using PGN 49664 (SPNs 3048 to 3049, 3066 to 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) using PGN 64896 (SPNs 1213 to 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) using 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) using PGN 64898 (SPNs 1213 to 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) using PGN 40448 (SPNs 4104 to 4108)].

6.9.15.2　Fail Criteria

a.　Fail if any ECU reports a count greater than 0 for emission-related pending DTCs, MIL-on DTCs, or previous MIL on DTCs.

b.　Fail if no ECU reports a count greater than 0 for permanent DTCs.

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 a count greater than 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 = FFh.

6.9.15.3　Warn Criteria

a.　Warn if any ECU reports a count greater than 1 for permanent DTC.

b.　Warn if more than one ECU reports a count greater than 0 for permanent DTCs.

6.9.16　DM26: Diagnostic Readiness 3

6.9.16.1　Actions

a.　DS DM26 [send Request (PGN 59904) using 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 greater than 0.

b.　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) using 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 to 5 = 00h, bytes 6 to 8= FFh).

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) using PGN 64949 (SPNs 1213 to 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) using PGN 65236 (SPNs 1213 to 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.

6.9.19.3   DM6: Emission Related Pending DTCs

6.9.19.4   Actions

a.   Global DM6 [send Request (PGN 59904) using PGN 65227 (SPNs 1213 to 1215, 1706, and 3038)].

6.9.19.5   Fail Criteria

a.   Fail if any ECU reports a pending DTC.

b.   Fail if no OBD ECU provides a DM6 message.

6.9.19.6   Actions

a.   DS DM6 to each OBD ECU.

6.9.19.7   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.

6.9.20   DM5: Diagnostic Readiness 1

6.9.20.1   Actions

a.   Global DM5 [send Request (PGN 59904) using PGN 65230 (SPNs 1218 to 1219)].

6.9.20.2   Fail Criteria

a.   Fail if any OBD ECU reports a count greater than 0 active DTCs or greater than 0 previously active DTCs.

6.9.21   DM2: Previously Active Diagnostic Trouble Codes (DTCs)

6.9.21.1   Actions

a.   Global DM2 [send Request (PGN 59904) using PGN 65227 (SPNs 1213 to 1215, 1706, and 3038)].

6.9.21.2   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.

6.9.21.3   Actions

a.   DS DM2 to each OBD ECU.

6.9.21.4   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.

6.9.22   DM1: Active Diagnostic Trouble Codes (DTCs)

6.9.22.1   Actions

a.   Receive DM1 broadcast [PGN 65226 (SPNs 1213 to 1215, 1706, and 3038)].

6.9.22.2   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.

6.9.23   DM33: Emission Increasing Auxiliary Emission Control Device Active Time

6.9.23.1   Actions

a.   DS DM33 [send Request (PGN 59904) using PGN 41216 (SPNs 4124 to 4126)] to each OBD ECU.

6.9.23.2   Fail Criteria

a.   Fail if any ECU reports a different number EI-AECD than was reported in part 2. [Engines using SI technology need not respond until the 2024 engine model year].

b.   Compare to list of ECU addresses, EI-AECD numbers, and actual time (for Timer 1 and/or Timer 2) for any with non-zero timer values observed earlier in step 6.9.7.1 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.

6.9.24   Part 9 to Part 10 Transition

6.9.24.1   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 the engine speed is less than 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 the engine speed is less than 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) using PGN 64896 (SPNs 1213 to 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 second 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 minutes shall be above 1150 RPM. At least 30 seconds of the 10 minutes shall be at idle. See 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., SPNSPN 190).

6.11.1.2   Warn Criteria

a.   If the engine speed is less than 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) using 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

a.   If more than one ECU responds, fail if times (since engine start) differ by more than 2 seconds.

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) using 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) using PGN 40448 (SPNs 4104 to 4108)].

6.11.4.2   Fail Criteria

a.   Fail if any ECU reports a count greater than 0 for emission-related pending DTCs, MIL-on DTCs, or previous MIL on DTCs.

b.   Fail if no ECU reports a count greater than 0 for permanent DTCs.

c.   For ECUs that support DM27, (SPN 4105).

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

6.11.4.3   Warn Criteria

a.   Warn if any ECU reports a count greater than 1 for permanent DTC.

b.   Warn if more than one ECU reports a count greater than 0 for permanent DTCs.

6.11.5   DM20: Monitor Performance Ratio

6.11.5.1   Actions

a.   Global DM20 [send Request (PGN 59904) using PGN 49664 (SPNs 3048 to 3049, 3066 to 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) using PGN 64896 (SPNs 1213 to 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. Evaluation of Table A2 criteria shall commence only after 300 seconds of engine operation above 1150 RPM have been observed.

b.   Wait 3 minutes.

c.   Increase engine speed over 1150 RPM (a minimum of 300 seconds 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 second) while timing engine operation versus the general denominator timing requirement.

e. Periodic operating summaries and query results shall be reported in the log, at intervals no greater than 20 seconds. Also report DM20 and DM28 queries, and messages when failure and warning criteria are met for DM20 or DM28.

f. After 300 seconds of engine operation above 1150 RPM has been observed, 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 A2, or otherwise meets failure criteria during engine idle speed periods, after 300 seconds of engine operation above 1150 RPM have been observed.

6.11.7.3   Warn Criteria

a. Identify any broadcast data meeting warning criteria in Table A2 during engine idle periods, after 300 seconds of engine operation above 1150 RPM have been observed.

6.11.7.4   Actions2

a. Once 620 seconds of engine operation overall in part 11 have elapsed (including over 300 seconds 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) using PGN 49664 (SPNs 3048 to 3049, 3066 to 3068)] to ECUs that reported DM20 data earlier in this part.

b. If no response [transport protocol RTS or NACK(Busy) in 220 ms], then retry DS DM20 request to the OBD ECU. (Do not attempt retry for NACKs that indicate not supported).

6.11.8.2   Fail Criteria

a. Fail if retry was required to obtain DM20 response.

b. Fail if any response indicates that the general denominator (SPN 3049) has not incremented by one from value earlier in part 9.

c. Fail if NACK received from OBD ECUs that previously provided a DM20 message.

6.11.8.3 Warn Criteria [for monitor labels with numerators and denominators not broadcast as FFFFh/FFFFh (unsupported)]

a. Warn if any response indicates a supported denominator for SCR (SPN 4792, 4364, or 5308), Catalyst (SPN 3050), EGR (SPN 3058) NOx sensor (SPN 5318), boost (SPN 5321) and fuel system (SPN 3055) 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) using PGN 64896 (SPNs 1213 to 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) using PGN 65230 (SPNs 1218 to 1223)] to each OBD ECU.

b. Record all data (i.e., which monitors are supported and complete or supported and incomplete).

c. 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) using PGN 64952 (SPNs 3301 to 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 seconds from expected value (calculated by software using original DM26 response in this part plus accumulated time since then);

    i.e., Fail if ABS [(Time Since Engine Start$_B$ - Time Since Engine Start$_A$) - Delta Time] > 10 seconds.

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) using PGN 49408 (SPNs 3294, 3296)] to each OBD ECU.

6.11.12.2 Fail Criteria

a. If Time SCC (SPN 3296) is supported, Fail if Time SCC differs by more than ±1 minute from the expected value (calculated using the original DM26 response in this part from 6.11.3 plus the accumulated time since then);

    i.e., Fail if ABS[(Time SCC$_B$ - Time SCC$_A$) (minutes) - Truncate((Time Since Engine Start$_B$ - Time Since Engine Start$_A$) / 60 (seconds/minute))] > 1 minute.

b. Fail if the distance SCC (SPN 3294) is greater than 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 seconds.

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 the engine speed is greater than 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) using PGN 64952 (SPNs 3303 to 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) using 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) using PGN 64896 (SPNs 1213 to 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) using PGN 40448 (SPNs 4104 to 4108)].

6.12.5.2   Fail Criteria

a.   Fail if any ECU reports a count greater than 0 for emission-related pending DTCs, MIL-on DTCs, previous MIL on DTCs, or permanent DTCs.

b.   For OBD ECUs that support DM27, fail if any ECU reports a count greater than 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 = FFh.

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 to 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) using PGN 49408 (SPNs 3294, 3296)].

6.12.7.2   Fail Criteria

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

b.   Fail if any ECU reports a time less than 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 for each SPN and FMI from list created in part 1.

b.   Record all values for any ECU address and SPN and 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) using 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.   Info: if any OBD ECU responds with an ACK.

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

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 and FMI that had non-initialized values earlier in part 12 test 8.

b.   Use responses to help verify coordinated DM11 code clear in this part (i.e., all or no ECUs clear).

     For example, this will be evident in the increased count of initialized test results for the SPN and FMI pairs that were listed with non-initialized values.

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 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 needs a recommended method for creating a DM12 fault.

6.13.1   Step-Wise Parallel Evaluation of Components

The procedure in 6.1 through 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 6.1 through 6.12 presume that each device in a distributed system is 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. Screen the distributed system for sequential evaluation. Execute parts 1 and 2 once. Review responses for omissions in supported content. Review monitor support bits for individual and system wide coverage. Asymmetric responses for J1939-84 DMs require non-responding devices to NACK direct requests when global queries are not supported. Review the CAL ID and CVN for each ECU in the distributed system for proper responses.

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. Demonstrations may choose to provide Fault A and Fault B from disparate ECUs to demonstrate detection and freeze frame coordination capabilities in a single run.

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 is recommended 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 2 shows which services are tested under each operating condition.

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

Table 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 is conducted on a production vehicle containing no faults with the test computer connected via the SAE J1939-13 diagnostic connector. Formal testing shall follow the order defined in this section.

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

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

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

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

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

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

f. The test computer shall 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 shall be verified or the diagnostic link shall 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 seconds. Connect test computer to the SAE J1939-13 connector.

•   Turn ignition on. Do not crank engine.

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

7.1.2   Verify Communication, Ignition On, Engine Off

Purpose:

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

Procedure:

•   Test computer sends a SAE J1939 request message for DM5.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CE
Byte 2	(i.e., DM5 - PGN = 65230, 00FECEh)	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 (PG 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 shall 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 shall 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 shall 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	D3
Byte 2	(i.e., DM11 - PGN = 65235, 00FED3h)	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	D3
Byte 7	(i.e., DM11 - PGN = 65235, 00FED3h)	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 shall respond with message as shown in the response in Figure 6. 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 shall indicate whether the MIL will be illuminated after engine is started. It should not reflect the status of the MIL bulb driver circuit, which turn 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	D4
Byte 2	(i.e., DM12 - PGN = 65236, 00FED4h)	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 (PG 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 shall respond with a message as shown in the response in Figure 8. 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	CF
Byte 2	(i.e., DM6 - PGN = 65231, 00FECFh)	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 (PG 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 shall 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 use the SAE J1939 Transport Protocol. Note the SPNs reported by each ECU, as being supported.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	0 (Engine), other OBD-compliant ECUs	
Data:	**Data Description**	**Byte Value (Hex)**
Byte 1	PGN of requested message	B6
Byte 2	(i.e., DM24 - PGN = 64950, 00FCB6h)	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 (PG 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 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 shall 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 shall 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 shall ensure that the engine is running when performing the test, e.g., turn on A/C.

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

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

Purpose:

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

Procedure:

- Test computer transmits 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	CD
Byte 2	(i.e., DM4 - PGN = 65229, 00FECDh)	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 (PG 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 supports Freeze Frame; 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 provides bytes 1 to 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	EC
Byte 2	(i.e., Vehicle ID - PGN = 65260, 00FEECh)	FE
Byte 3		00

Figure 15 - VIN request message

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

Figure 16 - ECU#X response: VIN message

Evaluation Criteria:

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

• The VIN year character (position 10) shall correspond to the model year entered by the operator in the test computer and shall 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	00
Byte 2	(i.e., DM19 - PGN = 54016, 00D300h)	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 shall 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 shall report its own CAL ID; however, some ECUs can 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 determine 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 generates a MIL light and a single DTC with the engine idling in preparation for the services tests in the remainder of the tests in this section.

Procedure:

- With ignition off and engine off, disconnect a sensor that is tested continuously (e.g., engine coolant temperature, intake manifold pressure, atmospheric pressure, fuel pressure, etc.).

Fault Selection Criteria:

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

- The selected fault shall illuminate the MIL during the first driving cycle to allow proper testing in a manufacturing setting. In this case, a pending DTC a confirmed DTC and MIL shall 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 shall ensure that the engine is on when performing the test, e.g., turn on A/C or defroster.

7.4.2   Establish Communication (SAE J1939), Engine Running

Purpose:

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

Procedure:

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

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CE
Byte 2	(i.e., DM5 - PGN = 65230, 00FECEh)	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 (PG 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 second, test computer shall send a SAE J1939 Request message for DM6 to Global Address to get pending DTCs. If DTC is set, test computer shall prompt user that DTC has been set and to continue. If no pending DTC is set, after 30 seconds the test computer shall prompt the user to continue without a pending DTC (logged as a failure).

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CF
Byte 2	(i.e., DM6 - PGN = 65231, 00FECFh)	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 (PG 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 Count]	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 Count]	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 shall send a SAE J1939 Request message for DM25 to the Global destination address to read freeze frame data (DTC).

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	B7
Byte 2	(i.e., DM25 - PGN = 64951, 00FDB7h)	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 (PG 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 Count]	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 Count]	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 shall send a SAE J1939 Request message for DM4 to the devices that responded to DM5 as an OBD-compliant device.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	0 (Engine), other OBD-compliant ECUs	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	CD
Byte 2	(i.e., DM4 - PGN = 65229, 00FECDh)	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 (PG 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 Count]	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 Count]	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 00h in byte 1, 00h in bytes 2 through 5 and FFh in bytes 6 through 8.

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

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

7.6.2   Pending Fault Freeze Frame

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

Procedure:

- The test computer shall send a SAE J1939 Request message for DM4 to the devices that responded to DM5 as an OBD-compliant device.

Evaluation Criteria:

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

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

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

7.7   Verify DM24 - Request SPN Support (DM24)

Purpose:

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

Procedure:

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

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	B6
Byte 2	(i.e., DM24 - PGN = 64950, 00FDB6h)	FD
Byte 3		00

Figure 28 - SPN support (DM24) request message

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

Figure 29 - ECU#X response: SPN support (DM24) response message

Evaluation Criteria:

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

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

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

Purpose:

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

Procedure:

- The test computer shall send a SAE J1939 Request message for DM12 to the Global Destination address. Verify that a proper response is received.

Message PGN:	59904 (Request)	
Source Addr:	SA of Test Computer	
Destination Addr:	255 (Global destination)	
Data:	Data Description	Byte Value (Hex)
Byte 1	PGN of requested message	D4
Byte 2	(i.e., DM12 - PGN = 65236, 00FED4h)	FE
Byte 3		00

Figure 30 - Emission related diagnostic trouble code (DM12) request message

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

Figure 31 - ECU#X response: emission related DTCs (DM12) response message

Evaluation Criteria:

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

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

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

8. NOTES

8.1 Application Notes

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

8.2 Key Dependencies for Implementers

The content in SAE J1939-84 depends greatly upon the content provided in SAE J1939-21, SAE J1939-73, SAE J1939-71, and SAE J1939-DA. For example:

- SAE J1939-21:

  ○ Interpretation of response timeouts.

  ○ Number of retries.

  ○ ACK methods and control byte assignments.

- SAE J1939-71 and SAE J1939-DA:

  ○ Asterisk delimiter "*" for alpha-numeric content.

  ○ Review of special values FFh, FEh, and FEh et al.

  ○ Message timing for broadcast messages.

- SAE J1939-73:

    ○ Mil_Status data values assignments.

    ○ DMxx Message Content.

    ○ Destination Specific request limitations for DM24 and other multipacket message content instructions.

Key concerns from these documents are highlighted in footnotes and in the Roman numeral outline that precedes 6.1.

8.3   Prefix Numerical Notation

The suffixes b and h denote that the preceeding digits are binary (base 2) or hexadecimal (base 16) digits respectively.

8.4   Revision Indicator

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

8.5   Revision History Summary

The summary of revisions since CARB began demanding specific tests content is reviewed in this section.

Revision	Change Summary
October 2017	The October 2017 version revised Table A2 for non OBD modules that provide battery voltage and Component ID. Table A2 adds parameters that are required of 2016MY engines, and improves plausible values. An informative message classification is added for certain warning messages that are of general interest. Non-OBD responses for commonly reused SPNs among non-OBD modules will no longer receive warning messages when provided by non-OBD modules. Four key destination specific queries in Section 6 were changed to allow a retry with failure, to better assure that key data used in criteria and other tests would be captured.
January 2016	The January 2016 version improved language that relies upon contextual technical details in referenced documents. An engine serial number evaluation was added to 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 A14 reflected 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.
February 2015	The February 2015 version of SAE J1939-84 replaced the test procedures in Section 6 in order to implement a two-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.
December 2010	The December 2010 version of the document added a test plan and procedure outline for ARB and U.S. 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.
December 2008	The December 2008 publication of SAE J1939-84 described a test process for EURO IV and EURO V engine emissions and diagnostics regulations, which is given in Section 7.

APPENDIX A - DATA EVALUATION METHODS

Appendix A provides additional evaluation criteria and procedure information that is not practical to include in the Section 6 outline. The content below contains normative data regarding the evaluation of ECU responses to Section 6 queries.

A.1   MINIMUM DATA STREAM SUPPORT

Table A2 provides a list of SPNs that all diesel engine powered vehicles should support. The columns of Table A2 are discussed in the notes in Table A1. These notes identify the evaluation intended by Table A2. The content of the SPN column in Table A2 shall be included in the list of SPNs identified in the DM24 response(s) provided by the OBD ECU(s) as described in Note 1.

Table A1 - Evaluation intended by Table A2

Note	Table A2 Column Title	Comments
1	SPN	Entries in Table A2 represent a subset of those SPNs which are expected in a DM24 message from an HD OBD ECU. Additional SPNs from those listed here are expected in DM24 responses. Query support for individual SPNs provided in a DM24 response that are not shown in Table A2 shall be assessed, but plausible values are not defined for the data returned. SPNs which appear in DM24 and that indicate data stream support shall not provide FFh (not available/not supported) or FEh (error) indicators. The SPN column also identifies alternative content. SPNs that are followed with an asterisk (*) shall be evaluated only on 2016 MY and newer engines.
2	Fail if SPN not supported in DM24	This column defines the minimum support requirement for DM24. Entries that say, "At least one" means that the SPNs listed provide a set of alternative selections from which one or more than one SPN shall be provided. SPN names that are followed with an SI shall be evaluated only for SI engines. Names followed with a CI shall be omitted for SI engines, and only evaluated for CI engines. Names that are followed with a blank are to be evaluated for both engines.
3	Warn/Info if SPN not supported in DM24	This column defines preferred SPNs among sets of alternatives and identifies SPNs that are expected from the plurality if not all HD OBD systems. Warning messages are provided when coded as "Warn", and informative messages are provided when coded as "Info".
4	Warn/Info if more than 1 SPN supported	This column defines if alternative selections are mutually exclusive. It does not apply to SPNs that are not included in a set as indicated by the value "At least one" which is discussed in Note 2. Warning messages are provided when coded as "Warn", and informative messages are provided when coded as "Info".
5	Action if two or more ECU's provide SP	This column defines which SPNs are expected to be provided by a single HD OBD ECU in the broadcast data stream. The criteria in column 5 shall be applied to both DM24 responses from a distributed system, and the broadcast data. A limited number of SPNs may be provided by any HD OBD ECU or may be provided by a Secondary HD OBD ECU as described in SAE J1939-73 Appendix H.
6	Action if SPN provided by non OBD Module	This column defines which SPNs are not plausibly provided by any ECU that does not support DM5 or that provides 5 or 255 (FFh) as the value for OBD_Compliance in DM5. The value None in this column also identifies SPNs that are used by both HD OBD and non HD OBD applications, or which may be provided by a Secondary HD OBD ECU.
7	Action if SPN provided but not included in DM24	This column defines those SPNs which are not plausibly excluded from an HD OBD system if provided by any ECU. A value of warn or info identifies data that might be provided by an SAE J1939-73 Appendix H OBD Secondary Module or Contributor
8	Warn if SPN value implausible	This column defines those SPNs for which plausible values have been defined for engine off and engine idle conditions. The listed plausible values shall be checked for any SPN that is provided with a valid data range as described in SAE J1939-71 {e.g., 0000h through FA00h for a 16-bit (2 byte) numeric field]. Plausible values are not provided for any other SPNs that are not listed in this column. KOER values apply only to stable engine low idle speeds.

Table A2 - Minimum data stream support

SPN	Name	PGN	Broadcast or Upon Request?	Fail if SPN is Not Supported in DM24	Warn/info if SPN is Not Supported in DM24	Warn/info if More Than 1 SPN is Supported	Action if Two or More ECUs Respond	Action if SPN Provided by Non-OBD Module	Action if SPN Provided but Not Included in DM24	Warn if Value Implausible	
										Engine Off	Engine On
92	Engine Percent Load At Current Speed	61443	BC 50 ms or RPM dependent	Yes	No	No	Fail	Fail	Fail	> 0%	>=50%
512	Driver's Demand Engine - Percent Torque	61444	BC RPM dependent	Yes	No	No	Fail	Fail	Fail	> 0%	> 0%
513	Actual Engine - Percent Torque	61444	BC RPM dependent	Yes	No	No	Fail	Fail	Fail	> 0%	>=50%
514*	Nominal Friction - Percent Torque	65247	BC 250 ms or RPM Dependent	Yes	No	No	None	Fail	Fail	> 0%	<= 0%
2978*	Estimated Engine Parasitic Losses - Percent Torque	65247	BC 250 ms or RPM Dependent	Yes	No	No	None	Fail	Fail	> 0%	<= 0%
539	Engine Percent Torque at Idle, Point 1	65251	BC 5 seconds and on change of torque/speed points of more than 10% since last	Yes	No	No	None	Fail	Fail	< 10%	< 10%
540	Engine Percent Torque at Point 2			Yes	No	No		Fail	Fail	< 10%	< 10%
541	Engine Percent Torque at Point 3			Yes	No	No		Fail	Fail	< 20%	< 30%
542	Engine Percent Torque at Point 4			Yes	No	No		Fail	Fail	< 15%	< 20%
543	Engine Percent Torque at Point 5			Yes	No	No		Fail	Fail	=> 100%	=> 100%
188	Idle Engine Speed	65251	BC 5 seconds and on change of torque/speed points of more than 10% since last	No	No	No	None	Fail	None	No	No
544	Engine Reference Torque	65251		Yes	No	No	Fail	Fail	Fail	< 200, > 4000	< 200, > 4000, <> KOEO value
110	Engine Coolant Temperature	65262	BC 1000 ms	At least one	Info	Info	Fail	Fail	Warn	< -7 °C, > 110 °C	< -7 °C, > 110 °C
1637	Engine Coolant Temperature (High Resolution)	65129	BC 1000 ms		No		Fail	Fail			
4076	Engine Coolant Temperature 2	64870	BC 1000 ms		No		Fail	Fail			
4193	Engine Coolant Pump Outlet Temperature	64870	BC 1000 ms		No		Fail	Fail			
190	Engine Speed	61444	BC RPM dependent	At least one	Warn	Info	Fail	Fail	Warn	> 0 RPM	< 250 RPM
4201	Engine Speed 1	61473	UR, then RPM dependent BC		No		Fail	Fail			
723	Engine Speed 2	61473	UR, then RPM dependent BC		No		Fail	Fail			
4202	Engine Speed 3	61473	UR, then RPM dependent BC		No		Fail	Fail			
84	Wheel-Based Vehicle Speed	65265	BC 100 ms	Yes	No	No	Warn	Warn	Warn	<> 0 mph	<> 0 mph

SPN	Name	PGN	Broadcast or Upon Request?	Fail if SPN is Not Supported in DM24	Warn/info if SPN is Not Supported in DM24	Warn/info if More Than 1 SPN is Supported	Action if Two or More ECUs Respond	Action if SPN Provided by Non-OBD Module	Action if SPN Provided but Not Included in DM24	Warn if Value Implausible Engine Off	Warn if Value Implausible Engine On
91	Accelerator Pedal Position 1	61443	BC 50 ms or RPM dependent	Yes	No	No	Fail	Warn	Warn	> 0%	> 0%
108	Barometric Pressure	65269	BC 1000 ms	Yes	No	No	Fail	Fail	Warn	< 25 kPa, > 110 kPa	No
158	Keyswitch Battery Potential	65271	BC 1000 ms	At least one	Info	No	None	Info	Warn	No	< 6 V
168	Battery Potential /Power Input 1	65271	BC 1000 ms		No		None	Info	None	No	< 6 V
5466*	Aftertreatment 1 Diesel Particulate Filter Soot Load Regeneration Threshold CI	64891	UR	Yes	Warn	No	Fail	Fail	Warn	No	No
3719	Aftertreatment 1 Diesel Particulate Filter Soot Load Percent CI	64891	UR	No	No	No	Fail	Fail	Fail	No	No
3700	Aftertreatment Diesel Particulate Filter Active Regeneration Status CI	64892	BC 1000 ms or change of state	Yes	No	No	Fail	Fail	Warn	status= active	No
5827	Aftertreatment 1 Average Distance Between Active DPF Regenerations CI	64920	UR	At least one	Warn	No	Fail	Fail	Warn	No	No
5454	Aftertreatment 1 Average Time Between Active Regenerations CI	64920	UR		No		Fail	Fail	Warn	No	No
235	Engine idle Hours	65244	UR	Yes	No	No	Fail	Warn	Warn	No	No
247	Engine run Hours	65253	UR	Yes	No	No	Fail	Warn	Warn	No	No
248	Engine PTO Hours	65255	UR	Yes	No	No	Fail	Warn	Warn	No	No
5837	Fuel Type	64962	UR	Yes	N/A	N/A	Fail	Fail	Warn	<> diesel CI = diesel SI	<> diesel CI = diesel SI
183	Engine Fuel Rate	65266	BC 100 ms	At least one	No	No	Fail	Fail	Warn	> 0	= 0, > 4 L/h
1600	High Res Engine Fuel Rate	64737	BC 100 ms		No		Fail	Fail	Warn	> 0	= 0, > 4 L/h
1413	Engine Cyl #1 Ignition Timing	65154	UR	At least one	No	No	Fail	Fail	Warn	N/A	N/A
1433	Engine Desired Ignition Timing	65159	UR		No		Fail	Fail	Warn	N/A	N/A
1436	Engine Actual Ignition Timing	65159	UR		No		Fail	Fail	Warn	N/A	N/A
3226	Aftertreatment 1 Outlet NOx CI	61455	BC 50 ms	Yes	N/A	N/A	Fail	Warn	Warn	<> FBh and > 500 ppb	No

SPN	Name	PGN	Broadcast or Upon Request?	Fail if SPN is Not Supported in DM24	Warn/info if SPN is Not Supported in DM24	Warn/info if More Than 1 SPN is Supported	Action if Two or More ECUs Respond	Action if SPN Provided by Non-OBD Module	Action if SPN Provided but Not Included in DM24	Warn if Value Implausible Engine Off	Warn if Value Implausible Engine On
132	Engine Intake Air Mass Flow Rate	61450	BC 50 ms	No	Warn	Warn	Fail	Fail	Warn	> 0.20 kg/hr	<= 0 kg/hr
6393	Engine Fuel System 1 Total Intake Mass Air Flow Rate	61497	BC 20 ms		No		Fail	Fail	Warn	> 0.04 kg/s	<= 0 kg/s
3609	Aftertreatment 1 Diesel Particulate Filter Intake Pressure CI	64908	BC 500 ms	At least one	No	No	Fail	Warn	Warn	> 0	No
3610	Aftertreatment 1 Diesel Particulate Filter Outlet Pressure CI	64908	BC 500 ms		No		Fail	Warn	Warn	> 0	No
3251	Aftertreatment 1 Diesel Particulate Filter Differential Pressure CI	64946	BC 500 ms		No		Fail	Warn	Warn	> 0	No
102	Engine Intake Manifold #1 Pressure	65270	BC 500 ms	At least one	No	No	Fail	Fail	Fail	> 2 kPa	> 10 kPa
106	Engine Intake Air Pressure	65270	BC 500 ms		No		Fail	Fail	Warn	> 104 kPa	> 111 kPa
1127	Engine Turbocharger 1 Boost Pressure	65190	BC 500 ms		No		Fail	Warn	Warn	> 2 kPa	> 10 kPa
3563	Engine Intake Manifold #1 Absolute Pressure	64976	BC 500 ms		No		Fail	Fail	Fail	> 104 kPa	> 111 kPa
2791	Engine Exhaust Gas Recirculation 1 Valve 1 Control 1	64981	UR	Yes	No	No	Fail	Fail	Warn	(No)	(No)
5829	Engine Exhaust Gas Recirculation 1 Valve 1 Position Error	64962	UR	Yes	No	No	Fail	Fail	Warn	> 5%	> 50%
27	Engine Exhaust Gas Recirculation 1 Valve Position	64916	BC 100 ms	Yes	No	No	Fail	Fail	Warn	(No)	(No)
94	Engine Fuel Delivery Pressure CI	65263	BC 500 ms	At least one	No	No	Fail	Fail	Warn	N/A	N/A
157	Engine Injector Metering Rail 1 Pressure CI	65243	BC 500 ms		Yes		Fail	Fail	Warn	N/A	N/A
164	Engine Injection Control Pressure CI	65243	BC 500 ms		No	No	Fail	Fail	Warn	N/A	N/A
5313	Commanded Engine Fuel Rail Pressure CI	64765	BC 100 ms		Yes		Fail	Fail	Warn	N/A	N/A
5314	Commanded Engine Fuel Injection Control Pressure CI	64765	BC 100 ms		No		Fail	Fail	Warn	N/A	N/A

SPN	Name	PGN	Broadcast or Upon Request?	Fail if SPN is Not Supported in DM24	Warn/info if SPN is Not Supported in DM24	Warn/info if More Than 1 SPN is Supported	Action if Two or More ECUs Respond	Action if SPN Provided by Non-OBD Module	Action if SPN Provided but Not Included in DM24	Warn if Value Implausible Engine Off	Warn if Value Implausible Engine On
5578	Engine Fuel Delivery Absolute Pressure ^{CI}	64735	BC 500 ms		No		Fail	Fail	Warn	N/A	N/A
175	Engine Oil Temperature 1	65262	BC 1000 ms	No	Yes	N/A	Fail	Warn	Info	< -7 °C, > 110 °C	< -7 °C, > 110 °C
6895*	Engine Exhaust Flow Rate	64587	UR	Yes	N/A	N/A	Fail	Fail	Warn	> 0	< 15 g/s
7333*	Cylinder Fuel Rate	64587	UR	Yes	N/A	N/A	Fail	Fail	Warn	> 0	N/A
3516*	Diesel Exhaust Fluid Concentration ^{CI}	64923	BC 1000 ms	At least one	No	No	Fail	Warn	Warn	N/A	N/A
3518*	Diesel Exhaust Fluid Conductivity ^{CI}	64923	BC 1000 ms		No		Fail	Warn	Warn	N/A	N/A
7346*	Diesel Exhaust Fluid Speed of Sound ^{CI}	64923	BC 1000 ms		No		Fail	Warn	Warn	N/A	N/A
3031*	Diesel Exhaust Fluid Tank 1 Temperature ^{CI}	65110	BC 1000 ms	At least one	No	No	Fail	Warn	Warn	< -7 °C, > 110 °C	< -7 °C, > 110 °C
3515*	Diesel Exhaust Fluid Temperature 2 ^{CI}	64923	BC 1000 ms		No		Fail	Warn	Warn		
96*	Fuel Level 1	65276	BC 1000 ms	No	Warn	No	Warn	Info	Info	N/A	N/A
38*	Fuel Level 2	65276	BC 1000 ms		No		Warn	Info	Info	N/A	N/A
2848*	Name of Controller Application	60928	UR (see SAE J1939-81)	No	No	No	None	None	None	N/A	N/A
51	Engine throttle valve position 1 ^{SI}	65266	100 ms	Yes ^{SI}	No	No	Fail	Fail	Fail	N/A	N/A
3464	Engine throttle actuator 1 control command ^{SI}	61466	50 ms or speed dependent	Yes ^{SI}	No	No	Fail	Fail	Fail	N/A	N/A
4236	Short-term fuel trim - bank 1 ^{SI}	64841	UR	Yes ^{SI}	No	No	Fail	Fail	Fail	N/A	N/A
4237	Long-term fuel trim - bank 1 ^{SI}	64841	UR	Yes ^{SI}	No	No	Fail	Fail	Fail	N/A	N/A
4240	Engine Exhaust Bank 1, O2 Sensor Closed ^{SI}	64841	UR	Yes ^{SI}	No	No	Fail	Fail	Fail	N/A	N/A
3249	Aftertreatment 1 exhaust gas temperature 2 ^{SI}	64946	500 ms	Yes ^{SI}	No	No	Fail	Fail	Fail	N/A	N/A
3245	Aftertreatment 1 exhaust gas temperature 3 ^{SI}	64947	500 ms	No ^{SI}	No	No	Fail	Fail	Fail	N/A	N/A
3241	Aftertreatment 1 exhaust gas temperature 1 ^{SI}	64948	500 ms	Yes ^{SI}	No	No	Fail	Fail	Fail	N/A	N/A

SPN	Name	PGN	Broadcast or Upon Request?	Fail if SPN is Not Supported in DM24	Warn/info if SPN is Not Supported in DM24	Warn/info if More Than 1 SPN is Supported	Action if Two or More ECUs Respond	Action if SPN Provided by Non-OBD Module	Action if SPN Provided but Not Included in DM24	Warn if Value Implausible	
										Engine Off	Engine On
3217	Engine exhaust 1 percent oxygen 1 [SI]	61454	50 ms	Yes [SI]	No	No	Fail	Fail	Fail	N/A	N/A
3227	Aftertreatment 1 Outlet %O2 [SI]	61455	50 ms	Yes [SI]	No	No	Fail	Fail	Fail	N/A	N/A

NOTE: The Engine On column plausible values are estimates for "no load" stable operating conditions at low idle engine speeds. Elevated engine speeds or elevated loads can exceed the values defined. Therefore, these limits should be assessed only for stable engine operating conditions with minimum engine loads.

The notes to Table A2 explain the purpose for the individual columns; more succinct, operational definitions for the columns in Table A2 are given below.

Table A3 - Operational definitions for Table A2

Table A2 Column	Table A2 Column Title	Operational Definition
1	SPN	When the HD OBD system is provided by more than one module, the composite response shall be considered. The indication of data stream support from any HD OBD module's DM24 response shall suffice for columns 2, 3, and 4. Since the SPN column also identifies alternative content, and DM24 response content may be limited to only the SPNs declared as part of the HD OBD system by the manufacturer, SPNs from the list may be observed within data provided by the HD OBD System that were not in the DM24 response. It shall be presumed that the data provided under these circumstances is not an error of omission for DM24, and the data shall be accepted with an informative message. Where SPN support for the data stream is not indicated in the DM24 response for a given SP, the value of FFh (not available / not supported) shall be accepted with no warning or informative message.
2	Fail if SPN not supported in DM24	Provide a failure message for each group of alternatives, if there does not exist an SPN in the list of SPNs provided by the DM24 response that is a member of the group of alternatives listed in Table A2 which has its data stream bit set for support by the responding device. [Note most SPNs are the only member in their group of alternatives].
3	Warn/Info if SPN not supported in DM24	Provide a warning or informative message for each group of alternatives, if there does not exist an SPN in the list of SPNs provided by the DM24 response that is a member of the group of alternatives listed in Table A2 which has its data stream bit set for support by the responding device.
4	Warn/Info if more than 1 SPN supported	Provide a warning or informative message for each group of alternatives, if there exists more than one SPN in the list of SPNs provided by the DM24 response that is a member of a group of alternatives listed in Table A2 which has its data stream bit set for support by the responding device.
5	Action if two or more ECU's provide SPN	Provide a failure, warning or informative message, if there exists an SPN listed in Table A2 that is provided by more than one module. The criteria in column 5 shall be applied to both DM24 responses from a distributed system, and the broadcast data.
6	Action if SPN provided by non OBD Module	Provide the indicated message if an SPN is observed in the data stream, whether it is broadcast, or provided as the response to a [global] request, by a module that is not self-identified as an HD OBD module as indicated by its OBD_Compliance field in its DM5 response.
7	Action if SPN provided, but not included in DM24	Provide the indicated message if an SPN is observed in the data stream (e.g. Part 1 test 26), whether it is broadcast or provided as the response to a [global] request, by the HD OBD system where no HD OBD module in the system identified the SPN for data stream support.
8	Warn if SPN value implausible	Provide a warning message for a listed SPN in Table A2 when the limit defined for the engine operating is exceeded. The listed plausible values shall be checked for any SPN that is provided with a valid data range as described in SAE J1939-71 (e.g. 0000h through FA00h for a 16-bit (two byte) numeric field). Plausible values are not provided for any other SPNs that are not listed in this column. KOER values apply only to stable engine low idle speeds.

When the HD OBD system responses are provided by more than one module, the composite response shall be considered when assessing the support requirements in Table A2. The storage of freeze frame and/or test results need not be provided by the module or device that provides data stream content. The following table explains the assessment of support for two modules and allows its comparsion with a monolithic system design that is illustrated subsequently. The binary example can be extended to three modules by duplication of the columns that say any for both the freeze frame and test results where device C would indicate yes.

Table A4 - DM24 Distributed System Outcome Archetypes

Device A DM24 Support Bits			Device B DM24 Support Bits			
Data Steam	Freeze Frame	Test Results	Data Steam	Freeze Frame	Test Results	Outcome
No	Any	Any	No	Any	Any	Fail (Part 1 Test 4) if SPN required in Table A2 (Fail if not Supported Column). [Use same message as an omitted SP]. Warn (Part 1 Test 4) if SPN is the preferred SPN of a group of alternatives.
No	Yes	Any	No	Any	Any	Warn (Part 1 Test 4) if Freeze Frame SPN is not listed as supported by Data Stream data stream bits for either Device A or Device B. Fail Data Steam Collection test (Part 1 test 26) if SPN is not observed.
No	Any	Any	No	Yes	Any	
No	Any	Yes	No	Any	Any	Warn (Part 1 Test 4) if Test Results SPN is not listed as supported by Data Stream data stream bits for either Device A or Device B. Fail Data Steam Collection test (Part 1 test 26) if SPN is not observed.
No	Any	Any	No	Any	Yes	
Yes	Any	Any	No	Any	Any	Pass if SPN (Part 1 Test 4) required in Table A2 (Fail if not Supported Column) Fail Data Stream Collection tests (Part 1 test 26) if SPN is not observed.
No	Any	Any	Yes	Any	Any	
Yes	Any	Any	Yes	Any	Any	Pass, Warn, or Fail (Part 1 Test 4) as provided by the definition for column 5 of Table A2, if more than one HD OBD ECU provides the same SPN for data stream support. Pass, Warn, or Fail (Part 1 Test 26) as provided by the definition for column 5 of Table A2, if more than one [HD OBD] ECU provides the same SPN as a part of the vehicle's data support.

Table A5 - DM24 Monolithic System Outcome Archetypes

DM24 Support Bits			
Data Steam	Freeze Frame	Test Results	Outcome
No	Any	Any	Fail if SPN (Part 1 Test 4) required in Table A2 (Fail if not Supported Column). [Use same message as an omitted SP]. [Else] Warn (Part 1 Test 4) if SPN is the preferred SPN of a group of alternatives.
No	Yes	Any	Warn (Part 1 Test 4) if a Freeze Frame SPN is not listed as supported by Data Stream data stream bits. Fail Data Steam Collection test (Part 1 test 26) if SPN is not observed.
No	Any	Yes	Warn (Part 1 Test 4) if Test Results SPN is not listed as supported by Data Stream data stream bits. Fail Data Steam Collection test (Part 1 test 26) if SPN is not observed.
Yes	Any	Any	Pass if SPN (Part 1 Test 4) required in Table A2 (Fail if not Supported Column) Fail Data Stream Collection tests (Part 1 test 26) if SPN is not observed.
No	No	No	Observe requirements in Table A2 column notes for SPNs not listed in DM24.

Engine serial number (ESN) is also a required element in OBD regulations, which shall be tested in Part 1 and Part 2. ESN is not included in Table A2 to limit queries for the Component ID PG to the specific tests provided for ESN in Part 1 and Part 2. The archetype evaluation criteria for Engine Make (SPN 586), Model (SPN 587), and Serial number (SPN 588) are described below. The archetype only applies to the response from Function 0. It does not apply to any the responses from non-OBD devices that may provide their own interpretation of make, model, and serial number without warnings or failures. Only HD OBD devices are required to respond with the engine running.

Table A6 - SPN 586, 587, and 588 example outcomes for the function 0 response

Component ID Archetype (from aaaaa*b…b*c…c*d…d*)	Outcome (More than one outcome is possible)
**c…c - Make, model not supported, ending delimiter missing	Warn - provide message for missing make Warn - provide message for missing model
**c…c* - Make, model not supported, unit number delimiter missing	Warn - provide message for missing make Warn - provide message for missing model
*b*c…c* - Make field missing (less than 2 characters)	Warn - provide message for missing make
a*b*c…c* - Make field too short (less than 2 characters)	Warn - provide message for missing make
aa**c…c* - Model field missing (less than 1 character)	Warn - provide message for missing model
aa*b** - Serial number missing (two *s define an empty string)	Fail - provide message for missing serial number
aa*b*12345*	Fail - provide message for serial number less than 6 characters. [62]
aa*b*AB12345A*	Fail - provide message for serial number not numeric in last five characters
aa*b*ABDC2345*	Fail - provide message for serial number not numeric in last five characters
aa*b*A1234*	Warn - provide message for serial number less than six characters
**A123456* - Make and model missing	Warn - provide message for missing make and model.
*AB123456** - Make and serial number missing	Fail - provide message for missing serial number. Warn - provide message for missing make.
AB123456* - Model and serial number missing	Fail - provide message for missing serial number. Warn - provide message for missing model. Warn - provide message for Make too long.
A12345 - Model and serial number missing	Fail - provide message for missing serial number. Warn - provide message for missing model. Warn - provide message for Make too long.
aa*b*AB123456 - Serial number delimiter not provided	Pass
aa*b*AB123456* - Unit number field and delimiter not provided	Pass
aa*b*AB123456** - Unit number field not provided	Pass
aa*b*AB123456*d…d - Unit number field delimiter missing	Pass
aa*b*AB123456*d…d* - Unit number field delimiter provided	Pass
aa*b*A123456* - Unit number field and delimiter not provided for seven character serial number	Pass
aa*b*AB123456** - Unit number field not provided	Pass [Left justified example ESN]
aa*b*AB123456 - ending delimiter missing	Pass [Right justified example ESN]
aa*b*AB12 456** - Unit number field not provided	Fail - Serial number not numeric in last 5 characters.
aa*b*A B123456** - Unit number field not provided	Fail - Serial number incorporates a space.
aa * b * A12345 - Unit number field and delimiter not provided for six character serial number	Pass
aa*b*A B123456 - ending delimiter missing	Fail - Serial number incorporates a space.

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[62] The engine serial number display can be right justified or left justified in a fixed width field (as defined by the engine manufacturer), both methods of justification shall be accepted by ignoring the padding of either binary zeros or ASCII blanks. The serial number, SPN 588, for function 0 shall not contain spaces or unprintable ASCII characters less than the numeric value of the space character, after justification for padding with leading or trailing binary zeros or ASCII spaces. Make and Model may contain ASCII spaces.

A.2　　CRITERIA FOR FREEZE FRAME EVALUATION

Section A.2 provides minimum content that shall be included in an HD OBD DM25 Expanded Freeze Frame response. This content is given in Table A7. DM24 responses shall be inspected for the inclusion of the SPNs in the left most column of Table A7 as having their freeze frame support bits set. The engine speed criteria prevents a freeze frame from eliciting multiple warning messages should the DTC be detected before the engine is started. One message is provided when the implanted DTC (Fault A) is detected when the engine is not running.

Table A7 - Criteria for freeze frame evaluation

SPN	Name	PGN	Fail if not supported in DM24:	Warn if:	Warn if value stored in DM25:
92	Engine Percent Load at Current Speed	61443	Yes		<= 0%, and RPM > 300
110	Engine Coolant Temperature	65262	At least one SPN shall be supported	Neither SPN 110 nor SPN 1637 is supported in DM24	< -7 °C or > 110 °C
1637	Engine Coolant Temperature (High Resolution)	65129			
4076	Engine Coolant Temperature 2	64870			
4193	Engine Coolant Pump Outlet Temperature	64870			
190	Engine Speed	61444	At least one SPN shall be supported	SPN 190 is not supported in DM24	<= 300 RPM
4201	Engine Speed 1	61473			
723	Engine Speed 2	61473			
4202	Engine Speed 3	61473			
512	Driver's Demand Engine - Percent Torque	61444	Yes		< 0% and RPM > 300
513	Actual Engine - Percent Torque	61444	Yes		<= 0% and RPM > 300
3301	Time Since Engine Start	64952	Yes		= 0 seconds and RPM > 300

A.3　　CRITERIA FOR VIN EVALUATION

Title 49 CFR Part 565 Subpart B-VIN Requirements describes detailed formatting and content requirements for a VIN used on a vehicle data plate. The requirements from Subpart B are to be used to assess the VIN received from a vehicle/engine ECU via PGN65260. Subpart B content can be found through the U.S. Government Printing Office at:

http://www.gpo.gov/fdsys/pkg/CFR-2011-title49-vol6/pdf/CFR-2011-title49-vol6-part565.pdf; or

http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div5&view=text&node=49:6.1.2.3.33&idno=49

Per 49 CFR §565.13 and §565.15 in Subpart B, the following elements shall be evaluated:

1.　Fail if the VIN is not equal to seventeen characters.

2.　Fail if the check digit (ninth character) does not match the expected check digit as calculated by the test software per §565.15(c).

3.　Fail if any character in the VIN is not within the ASCII letter range of 41h to 5Ah ('A' to 'Z') excluding 49h ('I') and 4Fh ('O') or within the ASCII number range of 30h to 39h ('0' to '9') according to the method given in §565.15.

4.　Fail if the last four characters (14th to 17th) are not within the ASCII number range of 30h to 39h ('0' to '9').

A.4   CRITERIA FOR MONITOR PERFORMANCE RATIO EVALUATION

Monitor performance ratio reporting identifies how frequently key emissions control subsystems are completely evaluated against a specific operating cycle definition (e.g., minimum 600 seconds in duration). In SAE J1939-73, this data is reported using DM20. Tests for DM20 shall consider the following factors during the evaluation of responses:

1. Each response from a responding ECU/device shall be evaluated separately:

    a. Fail if no response received from any OBD ECU (i.e., ECUs that indicates 13h, 14h, 22h, or 23h for OBD compliance in DM5).

    b. Warn if any response from non-OBD ECU received.

    c. Fail if any response does not report an ignition cycle counter and general denominator (bytes 1 to 4).

    d. Fail if any response does not correctly pad the unused bits (the 5 most significant bits set to one) of any of the SPNs for which it is reporting monitoring data (e.g., bytes 5 to 7, SPN 3066).

    e. Warn, if any SPN is reported but indicated as unsupported by reporting FFFFh for both the numerator (bytes 8 to 9, SPN 3067) and for the denominator (bytes 10 - 11, SPN 3068).

    f. Fail if any denominator (SPN 3068) for a reported SPN (SPN 3066) is greater than the general denominator (SPN 3049) reported by that ECU.

2. All responses received from all responding ECUs/devices shall be combined with appropriate 'AND/OR' logic to create a composite vehicle monitor performance response (i.e., if one or more responses indicates a particular SPN as supported with numerator and denominator data, then the composite vehicle monitor performance shall indicate that SPN is supported for monitor performance data else it shall indicate unsupported for that SP). Composite vehicle monitor performance support shall be evaluated:

    a. Fail if it does not indicate support for any of the SPNs in Table A8 (Diesel) or Table A9 (Spark Ignition) Composite Vehicle Monitor Performance Support.

Table A8 - Composite vehicle monitor support

Monitored System	SPN	SPN Name
NMHC Converting Catalyst	5322	Aftertreatment NMHC Converting Catalyst System Monitor
Exhaust Gas Sensor	5318	Aftertreatment Exhaust Gas Sensor System Monitor
EGR System	3058	EGR System Monitor
PM Filter	3064	Aftertreatment Diesel Particulate Filter System Monitor
Boost Pressure Control System	5321	Engine Intake Manifold Pressure System Monitor
Fuel system	3055	Engine Fuel System Monitor
NOx Catalyst Bank 1 or NOx Adsorber	4792, 5308, or 4364,	SPN 4792, Aftertreatment 1 SCR Catalyst System Monitor SPN 5308, Aftertreatment 1 NOx Adsorbing Catalyst System Monitor SPN 4364, Aftertreatment 1 SCR Conversion Efficiency (Warning)

Table A9 - Composite vehicle monitor support (Spark ignition)

Monitored System	SPN	SPN Name
Secondary Air	3054	Secondary Air System Monitor
EGR	3058	EGR System Monitor
VVT System	3306	Variable Valve Timing and/or Control
Evaporative Emissions	3053	Engine Evaporative System Monitor
Catalyst	3050	Catalyst Bank 1 System Monitor
Catalyst, Bank 2	3051	Catalyst Bank 2 System Monitor
Fuel system	3055	Engine Fuel System Monitor
Inlet Oxygen sensor bank 1	3056	Oxygen (or Exhaust Gas) Sensor Bank 1 Monitor
Inlet Oxygen sensor bank 2	3057	Oxygen (or Exhaust Gas) Sensor Bank 2 Monitor
Outlet Oxygen sensor bank 1	21227	Engine Exhaust Bank 1 Secondary O2 Sensor Monitor
Outlet Oxygen sensor bank 2	21228	Engine Exhaust Bank 2 Secondary O2 Sensor Monitor

A.5　　DIAGNOSTIC INFORMATION DEFINITION

Paragraph (h)(4.10) of Title 13 CCR 1971.1 identifies what diagnostic information is subject to change when "faults are cleared." Moreover, (h)(4.10) does not allow for piecemeal erasure of data, by an external request or command. All data defined in (h)(4.10) is to be erased or reset when any data is erased, when faults are cleared. This required action in (h)(4.10) shall be coordinated across all the OBD modules used in the system. Erasure of individual faults and freeze frame data from DM6 (Pending), DM12 (MIL-on, confirmed), DM23 (previous-MIL-on, confirmed), DM28 (permanent), and DM30 (Test Results) and DM25 (Freeze Frame), in conjunction with provisions in 13 CCR 1971 (d)(2) is not included in (this discussion of) the (h)(4.10) provisions. The data defined in (h)(4.10) includes:

a.　Emission-related DTCs (pending, active, and previously active but excluding permanent) including indications of the number of such DTCs currently stored;

b.　Emission-related Freeze Frame information (stored data and DTC related to the stored data); and

c.　MIL on information including commanded lamp status, distance traveled with MIL active, and engine runtime with MIL active.

It also includes information that shall be initialized/reset to provide indication of the recent code clear event including:

a.　Readiness status reset/initialized to indicate monitors not complete;

b.　Vehicle/engine activity since code clear initialized to zero including distance traveled since code clear, number of warm-ups since code clear, and engine runtime since code clear; and

c.　Test results (and limits) initialized to indicate that monitors have not run.

And lastly, there is specific information that is not allowed to be cleared/initialized upon a code clear event including:

a.　Monitor performance ratio information including ignition cycles, numerators, and denominators;[63]

b.　Permanent DTCs;[64]

c.　Engine runtime tracking information including engine runtime, idle time, and emission-increasing auxiliary emission control device (EI-AECD) activation time.[65]

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[63]　See 1971.1 section (h)(5.1.2)(A)(ii).
[64]　See 1971.1 section (h)(4.4.2)(F)(iii).
[65]　See 1971.1 section (h)(5.2.2)(B).

Accordingly, when the specification for SAE J1939-84 indicates the test shall verify that diagnostic information is erased, the following content shall be evaluated as defined by a given Section 6 test part:

1. Emission-related DTCs

    a. DM6 pending shall report no DTCs and MIL off and not flashing.

    b. DM12 active shall report no DTCs and MIL off and not flashing.

    c. DM23 previously active shall report no DTCs and MIL off and not flashing.

    d. DM29 shall report zero for number of pending, active, and previously active DTCs.

    e. DM5 shall report zero for number of active and previously active DTCs.

    Note: Simply checking fault displays for SPN 0, FMI 0 or counts for zero does not prove data was erased. In many instances the display provided no faults (shown as SPN 0, FMI 0) or counts prior to the "false" deletion stimulus (e.g DM3 or DM22) being assessed, and there was no data to erase, in error.

2. Freeze Frame information

    a. DM25 expanded freeze frame shall report no data and DTC causing freeze frame with bytes 1 to 5 = 0 and bytes 6 to 8 = 255.

3. MIL information

    a. DM31 lamp status shall report no DTCs causing MIL on (if supported). (See Section 6 provisions before 6.1.)

    b. DM21 diagnostic readiness 2 shall report 0 for distance with MIL on and minutes run with MIL on.

4. Readiness status

    a. DM5 shall report test not complete (1) for all supported monitors except comprehensive components.

5. Activity since code clear

    a. DM26 diagnostic readiness 3 shall report 0 for number of warm-ups since code clear.

    b. DM21 diagnostic readiness 2 shall report 0 for distance since code clear and minutes run since code clear.

6. Test results

    a. DM7/DM30 Test Results shall report all test results with initialized results and limits (all 00h or FB00h for results and FFFFh for limits).

7. Monitor performance data

    a. DM20 Monitor Performance Ratio data shall not be reset or display a value less than the prior value was before code clear for all values including the number of ignition cycles, general denominators, monitor specific numerators, and monitor specific denominators.*

8. Permanent DTCs

    a. DM28 permanent DTCs shall not be erased/still report any permanent DTC that was present before code clear.

9. Engine runtime information

   a. DM33 EI-AECD information shall not be reset or display a value less than the prior value for any non-zero values present before code clear.*

   b. Cumulative engine runtime, SPN 247 PGN 65253), shall not be reset or display a value less than the prior value for any non-zero values present before code clear.*

   c. (Cumulative) engine idle time, SPN 235 (PGN 65244) shall not be reset or display a value less than the prior value for any non-zero values present before code clear.*

   Whereas the baseline for monotonically increasing data items, that are not to be reset by a DM11 command, can increase from the last known value, the monotonically increasing attribute of such data shall be used to check for erased data by affirming (as failure criteria) that the current value is less than the last known value for the indicated items (in 7 and 9).

Likewise, when the specification indicates that the test shall verify no diagnostic information was erased, none of the above shall occur. The occurrence of any of the items above shall be considered an indication of some diagnostic information having been erased.

For reference, the material above may be compared with SAE J1939-73 FEB2010 Section 5.7.11, which states:

*   Number of diagnostic trouble codes (e.g., those read via DM5, DM29, etc.)

*   Diagnostic trouble codes for pending, active and previously active malfunctions

    ○ Emissions related pending DTCs (can be read with DM6)

    ○ Active diagnostic trouble codes (can be read with DM1)

    ○ Previously Active emissions related DTCs (can be read with DM23)

*   Number of DTCs and readiness information

    ○ Number of Active DTCs in ECU (can be read with DM5)

    ○ Number of Previously Active DTCs in ECU (can be read with DM5)

    ○ Readiness information read with DM5

    ○ Readiness information read with DM26

    ○ Number of MIL On DTCs and Previously MIL ON DTCs (can be read with DM29)

*   Trouble code for freeze frame data (can be read with DM25)

*   Freeze frame data (can be read with DM25)

*   Status of system monitoring tests (can be read with DM6)

*   All monitor Test Results (can be read with DM30)

*   Distance traveled while MIL is activated (can be read with DM21)

*   Number of warm-ups since DTC cleared (can be read with DM26)

*   Distance since diagnostic trouble codes cleared (can be read with DM21)

- Minutes run by the engine while MIL is activated (can be read with DM21)

- Time since diagnostic trouble codes cleared (can be read with DM21)

- Other manufacturer specific "clearing/resetting" actions may also occur in response to this request message

This summary should also be compared with (h)(4.10) from Title 13, California Code of Regulations, section 1971.1 June 17, 2010 which states:

> *(h)(4.10) Erasure of Emission-Related Diagnostic Information:*
> *(4.10.1) For purposes of section (h)(4.10), "emission-related diagnostic information" includes all the following:*
>   *(A) Readiness status (section (h)(4.1))*
>   *(B) Data stream information (section (h)(4.2)) including number of stored confirmed/MIL-on fault codes,*
>   *distance traveled while MIL activated, number of warm-up cycles since fault memory last cleared, and*
>   *distance traveled since fault memory last cleared.*
>   *(C) Freeze frame information (section (h)(4.3))*
>   *(D) Pending, confirmed, MIL-on, and previously MIL-on fault codes (section (h)(4.4.))*
>   *(E) Test results (section (h)(4.5))*
> *(4.10.2) For all vehicles, the emission-related diagnostic information shall be erased if commanded by a scan tool*
> *(generic or enhanced) and may be erased if the power to the on-board computer is disconnected. If any of the*
> *emission-related diagnostic information is commanded to be erased by a scan tool (generic or enhanced), all*
> *emission-related diagnostic information from all diagnostic or emission critical control units shall be erased.*
> *The OBD system may not allow a scan tool to erase a subset of the emission-related diagnostic information*
> *(e.g., the OBD system may not allow a scan tool to erase only one of three stored fault codes or only*
> *information from one control unit without erasing information from the other control unit(s)).*

A.6   CRITERIA FOR READINESS 1 EVALUATION

Section A.6 describes criteria for evaluation of readiness bits in SPNs 1221, 1222, and 1223 (bytes 4 to 8) of the DM5 message (PGN 65320). Parallel construction can be applied to SPNs 3303, 3304 and 3305 (bytes 4 to 8) in the DM26 message (PGN 59904) which share the same assignments of monitors to bits, except for the monitor inhibit status in DM26, but operates on a smaller time scale.

1. The response from each responding device shall be evaluated separately using a through d below:

   a. Fail if no response from an OBD ECU (ECUs that indicate 13h, 14h, 22h, or 23h for OBD compliance).

   b. Fail if any response does not report supported and complete for comprehensive components support and status (SPN 1221, byte 4, bit 3 = 1 and bit 7 = 0), except when all the bits in SPNs 1221, 1222, and 1223 are sent as 0 as defined in SAE J1939-73 paragraph 5.7.5.

   c. Fail if any response does not report 0 = 'complete/not supported' for the status bit for every unsupported monitors (i.e., any of the support bits in SPN 1221, byte 4 bits 1 to 3, SPN 1222 byte 5, bits 1 to 8, or SPN 1222 byte 6 bits 1 to 5 that report 0 also report 0 in the corresponding status bit in SPNs 1221 and 1223).

   d. Fail if any response does not report 0 for reserved bits (SPN 1221 byte 4 bits 4 and 8, SPN 1222 byte 6 bits 6 to 8, and SP1223 byte 8 bits 6 to 8).

2. All responses received from all responding OBD devices shall be combined with appropriate 'AND/OR' logic to create a composite vehicle readiness response: (Do not use responses from non-OBD devices to create a composite vehicle readiness response.)

   a. If one or more responses indicates 1 = supported in the support bit for a monitor,

      i.   Then the composite vehicle readiness shall indicate 1 = supported for that support bit/monitor,

      ii.   Else it shall indicate 0 = unsupported for that support bit/monitor;

    b.   If one or more responses indicates the status bit for a supported monitor is 1 = not complete,

        i.   Then the composite vehicle readiness shall indicate 1 = not complete for that status bit/monitor,

        ii.   Else it shall indicate 0 = complete for that status bit/monitor).

    c.   Fail if composite vehicle readiness does not meet any of the criteria in Table A10 (CI) or Table A11 (SI).

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

3.   All responses received from non-OBD ECU shall be evaluated using the criteria below:

    a.   Warn if any response from non-OBD ECU received.

    b.   Warn if all the monitor status and support bits in any reply from a non-OBD ECU are not all binary zeros or all binary ones.

SPN 1222, bit 7 (Exhaust Sensor Heater Monitor Support) may appear as a 0 with a warning message, instead of a requiring a failure message in 2013 MY engines. Future engine model years (c. 2016) shall unbundle all heater monitoring support and support both bits 7 and 6. When SPN 1222, bit 7 is provided as a 0 (not supported) after the 2013 engine model year, SPN 1223, bit 7 (Exhaust Sensor Heater Monitor Status) shall be provided as 0 (complete).

Specific implementations may require the immediate setting of the misfire monitor status bit to zero (complete). Refer to 13 CCR 1971.1 for such conditions. Observation of a zero (complete) for a misfire monitor status bit after fault codes have been cleared shall be marked with a warning message.

Table A10 - Composite vehicle readiness - diesel (CI) engines

SPN	Byte	Bit	SPN Name	Evaluation Criteria
1221	4	8	Reserved for assignment by SAE	must be 0
		7	Comprehensive Component monitoring status	must be 0 (complete)
		6	Fuel System monitoring status	must be 1, after code clear
		5	Misfire monitoring status	must be 1, after code clear, warn if 0
		4	Reserved for assignment by SAE	must be 0
		3	Comprehensive component monitoring support	must be 1 (supported)
		2	Fuel system monitoring support	must be 1
		1	Misfire monitoring support	must be 1
1222	5	8	EGR/VVT System monitoring support	must be 1
		7	Exhaust Gas Sensor Heater monitoring support	must be 1, warn if 0 for 2013 era engines
		6	Exhaust Gas Sensor monitoring support	must be 1
		5	A/C System Refrigerant monitoring support	must be 0 (not supported)
		4	Secondary Air System monitoring support	must be 0
		3	Evaporative System monitoring support	must be 0
		2	Heated Catalyst monitoring support	must be 0
		1	Catalyst monitoring support	must be 0
1222	6	8-6	Reserved for assignment by SAE	must be 0
		5	NMHC Converting Catalyst monitoring support	must be 1 (supported)
		4	NOx Converting Catalyst and/or NOx Adsorber monitoring Support	must be 1
		3	Diesel Particulate Filter (DPF) monitoring support	must be 1
		2	Boost Pressure Control System monitoring support	must be 1
		1	Cold Start Aid System monitoring support	may equal 0 or 1
1223	7	8	EGR/VVT System monitoring status	must be 1 (after code clear)
		7	Exhaust Gas Sensor Heater monitoring status	If not supported (byte 5, bit 7 be 0), must be 0. If supported, must be 1 (after code clear)
		6	Exhaust Gas Sensor monitoring status	must be 1 (after code clear)
		5	A/C System Refrigerant monitoring status	must be 0
		4	Secondary Air System monitoring status	must be 0
		3	Evaporative System monitoring status	must be 0
		2	Heated Catalyst monitoring status	must be 0
		1	Catalyst monitoring status	must be 0
1223	8	8-6	Reserved for assignment by SAE	must be 0
		5	NMHC Converting Catalyst monitoring status	must be 1 (after code clear)
		4	NOx Converting Catalyst and/or NOx Adsorber monitoring Status	must be 1 (after code clear)
		3	Diesel Particulate Filter (DPF) monitoring status	must be 1 (after code clear)
		2	Boost Pressure Control System monitoring status	must be 1 (after code clear)
		1	Cold start aid system monitoring Status	If not supported (byte 6, bit 1 = 0), must be 0. If supported (byte 6, bit 1 = 1), must be 1 (after code clear).

Note that cold start aid monitoring results, where equipped, can depend on cold soak or hot soak condition and ambient air temperature when an engine is started. Items listed as (after code clear) change from not complete (1) to complete (0) as the engine runs. Required monitors, except Continuous Component Monitoring (CCM), are expected to be supported by only one OBD ECU. While monitor support bit content in DM26 shall match the support bit content in DM5, the inhibited status data bits in DM26 are not guaranteed to match the status bits in DM5.

Table A11 - Composite vehicle readiness - spark ignition (SI) engines

SPN	Byte	Bit	SPN Name	Evaluation Criteria
1221	4	8	Reserved for assignment by SAE	must be 0
		7	Comprehensive Component monitoring status	must be 0 (complete)
		6	Fuel System monitoring status	must be 1 after code clear
		5	Misfire monitoring status	must be 0
		4	Reserved for assignment by SAE	must be 0
		3	Comprehensive component monitoring support	must be 1 (supported)
		2	Fuel system monitoring support	must be 1
		1	Misfire monitoring support	must be 1
1222	5	8	EGR/VVT System monitoring support	must be 1, warn if 0
		7	Exhaust Gas Sensor Heater monitoring support	must be 1
		6	Exhaust Gas Sensor monitoring support	must be 1
		5	A/C System Refrigerant monitoring support	must be 0 (not supported)
		4	Secondary Air System monitoring support	may equal 0 or 1, if so equipped
		3	Evaporative System monitoring support	must be 1
		2	Heated Catalyst monitoring support	must be 0, warn if 1
		1	Catalyst monitoring support	must be 1
1222	6	8-6	Reserved for assignment by SAE	must be 0
		5	NMHC Converting Catalyst monitoring support	must be 0 (not supported)
		4	NOx Converting Catalyst and/or NOx Adsorber monitoring Support	must be 0
		3	Diesel Particulate Filter (DPF) monitoring support	must be 0
		2	Boost Pressure Control System monitoring support	may equal 0 or 1, (use 0 for naturally aspirated engines)
		1	Cold Start Aid System monitoring support	must be 1, warn if 0
1223	7	8	EGR/VVT System monitoring status	must be 1 (after code clear)
		7	Exhaust Gas Sensor Heater monitoring status	If not supported (byte 5, bit 7 be 0), must be 0. If supported (byte 5, bit 7 = 1), must be 1 (after code clear)
		6	Exhaust Gas Sensor monitoring status	must be 1 (after code clear)
		5	A/C System Refrigerant monitoring status	must be 0
		4	Secondary Air System monitoring status	If not supported (byte 5, bit 4 = 0), must be 0. If supported (byte 5, bit 4 = 1), must be 1 (after code clear)
		3	Evaporative System monitoring status	must be 1
		2	Heated Catalyst monitoring status	If not supported (byte 5, bit 7 = 0), must be 0. If supported (byte 5, bit 7 = 0), must be 1 (after code clear)
		1	Catalyst monitoring status	must be 1
1223	8	8-6	Reserved for assignment by SAE	must be 0
		5	NMHC Converting Catalyst monitoring status	must be 0
		4	NOx Converting Catalyst and/or NOx Adsorber monitoring Status	must be 0
		3	Diesel Particulate Filter (DPF) monitoring status	must be 0
		2	Boost Pressure Control System monitoring status	If not supported (byte 6, bit 2 = 0), must be 0. If supported (byte 6, bit 2 = 1), must be 1 (after code clear)
		1	Cold start aid system monitoring Status	If not supported (byte 6, bit 1 = 0), must be 0. If supported (byte 6, bit 1 = 1), must be 1 (after code clear).

A.7   CRITERIA FOR TEST RESULTS EVALUATION

Section A.7 describes the evaluation of test results, including the definition of a minimum set for SPNs and FMIs to be supported as test results, for the HD OBD monitoring requirements given.

1. Each ECU/device that indicates one or more SPNs are supported for test results with a DM24 response shall be evaluated separately. The request (DM7) and response (DM30) for test results shall:

    a. Fail if no test result (comprised of a SPN and FMI with a test result and a minimum and maximum test limit) for an SPN indicated as supported is actually reported from the ECU/device that indicated support.

    b. Fail if any test result does not report the test result/min test limit/max test limit as initialized (after code clear) values (either FB00h/FFFFh/FFFFh or 0000h/0000h/0000h).

    c. Fail if the SLOT identifier for any test results is an undefined or a not valid SLOT in Appendix A of SAE J1939-71. See Table A14 for a list of the valid, SLOTs known to be appropriate for use in test results.

    d. Warn if any ECU reports more than one set of test results for the same SPN and FMI.

2. All DM30 responses shall be combined using appropriate "AND" logic to create a composite vehicle test results list (i.e., a list of each ECU address, SPN and FMI combination that test results were received for). Composite vehicle test results shall be evaluated and:

    a. Fail if no test result is received for any of the SPN and FMI combinations listed in Table A12 (CI) or Table A13 (SI)..

    b. Warn if more than one ECU responds with test results for the same SPN and FMI combination

Table A12 - Composite vehicle test results - diesel engines

Test Result Required	Monitor Name	DTC SPN	DTC FMI	SPN-FMI Description
At Least one of the three listed shall be provided	Fuel system pressure control low	157	18	Engine Injector Metering Rail 1 Pressure - Data Valid but Below Normal Operating Range - Moderately Severe Level
		164	18	Injection Control Pressure - Data Valid but Below Normal Operating Range - Moderately Severe Level
		3055	18	Fuel System Monitor- Data Valid but Below Normal Operating Range - Moderately Severe Level
At least one of the three listed shall be provided	Fuel system pressure control high	157	16	Engine Injector Metering Rail 1 Pressure - Data Valid but Above Normal Operating Range - Moderately Severe Level
		164	16	Injection Control Pressure - Data Valid but Below Normal Operating Range - Moderately Severe Level
		3055	16	Fuel System Monitor- Data Valid but Below Normal Operating Range - Moderately Severe Level
At least one of the four listed shall be provided	Injector Quantity (High Flow); or	651	7	Engine Injector Solenoid Driver Cylinder 1 - Mechanical System Not Responding or Out of Adjustment
		651	16	Engine Injector Cylinder #01 - Data Valid but Above Normal Operating Range - Moderately Severe Level
		5358	16	Engine Cylinder #1 Fuel Injection Quantity - Data Valid but Above Normal Operating Range - Moderately Severe Level
	Injector Timing	1413	16	Engine Cylinder #1 Ignition Timing - Data Valid but Above Normal Operating Range - Moderately Severe Level
At least one of the four listed shall be provided	Injector Quantity (Low Flow); or	651	7	Engine Injector Cylinder #01 - Mechanical System Not Responding or Out of Adjustment
		651	18	Engine Injector Cylinder #01 - Data Valid but Below Normal Operating Range - Moderately Severe Level
		5358	18	Engine Cylinder #1 Fuel Injection Quantity - Data Valid but Below Normal Operating Range - Moderately Severe Level
	Injector Timing	1413	18	Engine Cylinder #1 Ignition Timing - Data Valid but Below Normal Operating Range - Moderately Severe Level
Yes	% of misfire	1323	31	Engine Misfire Cylinder #1 - Condition Exists

Test Result Required	Monitor Name	DTC SPN	DTC FMI	SPN-FMI Description
Yes	% of misfire	1324	31	Engine Misfire Cylinder #2 - Condition Exists
Yes	% of misfire	1325	31	Engine Misfire Cylinder #3 - Condition Exists
Yes	% of misfire	1326	31	Engine Misfire Cylinder #4 - Condition Exists
At least one of the three listed shall be provided	Low Flow	3058	18	EGR System Monitor - Data Valid but Below Normal Operating Range - Moderately Severe Level
		2659	18	Engine Exhaust Gas Recirculation 1 Mass Flow Rate - Data Valid but Below Normal Operating Range - Moderately Severe Level
		411	18	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Valid but Below Normal Operating Range - Moderately Severe Level
At least one of the three listed shall be provided	High Flow	3058	16	EGR System Monitor - Data Valid but Above Normal Operating Range - Moderately Severe Level
		2659	0	Engine Exhaust Gas Recirculation 1 Mass Flow Rate - Data Valid but Above Normal Operational Range - Most Severe Level
		2659	16	Engine Exhaust Gas Recirculation 1 Mass Flow Rate - Data Valid but Above Normal Operating Range - Moderately Severe Level
		411	16	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Valid but Above Normal Operating Range - Moderately Severe Level
At least one of two shall be provided	Cooler performance	4752	1	Engine Exhaust Gas Recirculation 1 Cooler Efficiency Data Valid but Above Normal Operating Range - Least Severe Level
		4752	18	Engine Exhaust Gas Recirculation 1 Cooler Efficiency - Data Valid but Below Normal Operating Range - Moderately Severe Level
At least one of the five listed shall be provided	Under Boost	102	17	Engine Intake Manifold #1 Pressure - Data Valid but Below Normal Operating Range - Least Severe Level
		102	18	Engine Intake Manifold #1 Pressure - Data Valid but Below Normal Operating Range - Moderately Severe Level
		1127	18	Engine Turbocharger 1 Boost Pressure - Data Valid but Below Normal Operating Range - Moderately Severe Level
		3563	18	Engine Intake Manifold #1 Absolute Pressure - Data Valid but Below Normal Operating Range - Moderately Severe Level
		4817	18	Engine Intake Manifold 1 Absolute Pressure (High Res.) - Data Valid but Below Normal Operating Range - Moderately Severe Level
At least one of the four listed shall be provided	Over Boost	102	16	Engine Intake Manifold #1 Pressure - Data Valid But Above Normal Operating Range - Moderately Severe Level
		1127	16	Engine Turbocharger 1 Boost Pressure - Data Valid But Above Normal Operating Range - Moderately Severe Level
		3563	16	Engine Intake Manifold #1 Absolute Pressure - Data Valid But Above Normal Operating Range - Moderately Severe Level
		4817	16	Engine Intake Manifold 1 Absolute Pressure (High Res.) - Data Valid but Above Normal Operating Range - Moderately Severe Level
At least one of the four listed shall be provided	Charge Air Undercooling	2630	16	Engine Charge Air Cooler 1 Outlet Temperature - Data Valid but Above Normal Operating Range - Moderately Severe Level
		105	16	Engine Intake Manifold 1 Temperature - Data Valid but Above Normal Operating Range - Moderately Severe Level
		1636	16	Engine Intake Manifold 1 Air Temperature (High Resolution) - Data Valid but Above Normal Operating Range - Moderately Severe Level
		5285	18	Engine Charge Air Cooler Efficiency - Data Valid but Below Normal Operating Range - Moderately Severe Level
At least one of the three listed shall be provided	Conversion Efficiency, or	5018	18	Aftertreatment 1 Diesel Oxidation Catalyst System - Data Valid but Below Normal Operating Range - Moderately Severe Level
	Aftertreatment Assistance: Exotherm to assist PM reg., or	5298	18	Aftertreatment 1 Diesel Oxidation Catalyst Conversion Efficiency - Data Valid but Below Normal Operating Range - Moderately Severe Level
	Aftertreatment Assistance: Feedgas to assist SCR	5300	31	Aftertreatment 1 Diesel Oxidation Catalyst Insufficient NO2 Conversion - Condition Exists

Test Result Required	Monitor Name	DTC SPN	DTC FMI	SPN-FMI Description
At least one of the three listed shall be provided	Conversion Efficiency	4364	17	Aftertreatment 1 SCR Conversion Efficiency - Data Valid but Below Normal Operating Range - Least Severe Level
		4364	18	Aftertreatment 1 SCR Conversion Efficiency - Data Valid but Below Normal Operating Range - Moderately Severe Level
		4364	31	Aftertreatment 1 SCR Conversion Efficiency - Condition Exists
At least one of the four listed shall be provided	SCR or Other Reductant delivery performance	3361	7	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit - Mechanical system not responding or out of adjustment
		4331	15	Aftertreatment 1 Diesel Exhaust Fluid Actual Dosing Quantity - Data Valid but Above Normal Operating Range - Least Severe Level
		4331	18	Aftertreatment 1 Diesel Exhaust Fluid Actual Dosing Quantity - Data Valid but Below Normal Operating Range - Moderately Severe Level
		4334	18	Aftertreatment 1 Diesel Exhaust Fluid Doser 1 Absolute Pressure - Data Valid but Below Normal Operating Range - Moderately Severe Level
At least one of the four listed shall be provided	Filtering Performance	3251	2	Aftertreatment Diesel Particulate Filter Differential Pressure Sensor - Data erratic, intermittent or incorrect
		3936	2	Aftertreatment 1 Diesel Particulate Filter System - Data erratic, intermittent or incorrect
		3936	16	Aftertreatment 1 Diesel Particulate Filter System - Data Valid but Above Normal Operating Range - Moderately Severe Level
		3936	18	Aftertreatment Diesel Particulate Filter System - Data Valid but Below Normal Operating Range - Moderately Severe Level
At least one of the three listed shall be provided	Incomplete regeneration	3713	31	DPF active regeneration inhibited due to active system timeout.
		5319	7	Aftertreatment 1 Diesel Particulate Filter Incomplete Regeneration - Mechanical system not responding or out of adjustment
		5319	31	Aftertreatment 1 Diesel Particulate Filter Incomplete Regeneration - Condition Exists
At least one of the two listed shall be provided	NOx Sensor 1. Performance 4. Monitoring Capability	3226	16	Aftertreatment 1 Outlet NOx - Data Valid but Above Normal Operating Range - Moderately Severe Level
		3226	20	Aftertreatment 1 Outlet NOx - Data Drifted High

Table A13 - Composite vehicle test results for SI engines

Test Result Required	Monitor Name	DTC SPN	DTC FMI	SPN-FMI Description
At least one of the two listed FMIs shall be provided for each cylinder SPN listed.	% of misfire	1323	16	Engine Misfire Cylinder #1 -- Condition Exists
			31	
	% of misfire	1324	16	Engine Misfire Cylinder #2 -- Condition Exists
			31	
	% of misfire	1325	16	Engine Misfire Cylinder #3 -- Condition Exists
			31	
	% of misfire	1326	16	Engine Misfire Cylinder #4 -- Condition Exists
			31	
At least one of the two listed shall be provided	Conversion Efficiency	3050	18	Catalyst Bank 1 Conversion Efficiency
		6652	18	Aftertreatment 1 Three Way Catalyst Conversion Efficiency
At least 2 FMIs shall be returned for the listed SP	Engine Exhaust Sensor	3217	> 1 FMIs	Aftertreatment 1 Intake Percent O2
At least 2 FMIs shall be returned for the listed SP	Engine Exhaust Sensor	3227	> 1 FMIs	Aftertreatment 1 Outlet Percent O2
At least one of the two listed FMIs shall be provided	Engine Exhaust Sensor Heater	3222	1	Aftertreatment 1 Intake Gas Sensor Heater
			2	
At least one of the two listed FMIs shall be provided	Engine Exhaust Sensor Heater	3232	1	Aftertreatment 1 Outlet Gas Sensor Heater
			2	
At least one of the three listed shall be provided	Conversion Efficiency	4364	17	Aftertreatment 1 SCR Conversion Efficiency -- Data Valid But Below Normal Operating Range - Least Severe Level
		4364	18	Aftertreatment 1 SCR Conversion Efficiency -- Data Valid But Below Normal Operating Range - Moderately Severe Level
		4364	31	Aftertreatment 1 SCR Conversion Efficiency -- Condition Exists
At least one of the four listed shall be provided	Fuel System Monitor	651	3	Cylinder 1 Imbalance
		651	4	Cylinder 1 Imbalance
		651	5	Cylinder 1 Imbalance
		6575	2	Engine Main Chamber Air Fuel Ratio
At least one of the three listed shall be provided	EVAP Monitor [Only Warn if No EVAP monitor tests are provided]	7835	7	EVAP Large Leak
			20	EVAP Large Leak
			21	EVAP Large Leak

Table A14 - Valid slot identifiers for DM30 test results

Slot Identifier	Slot Name	Slot Identifier	Slot Name	Slot Identifier	Slot Name	Slot Identifier	Slot Name
5	SAEtm12	143	SAEec06	347	SAEev06	436	SAEec10
8	SAEad04	144	SAEfq01	348	SAEpp03	437	SAEpw08
9	SAEad05	145	SAEev02	349	SAEpp04	438	SAEec11
10	SAEad02	146	SAEec04	350	SAEfl03	440	SAEarms01
12	SAEct04	151	SAEpf01	351	SAEca04	441	SAEec12
13	SAEds03	162	SAEprc01	352	SAEec07	442	SAEvrms02
14	SAEds04	206	SAEtm13	353	SAEtm22	443	SAEpwr01
16	SAEel01	208	SAEct05	354	SAEen02	444	SAEec13
17	SAEeg01	211	SAEca01	355	SAEpr18	445	SAEds19
18	SAEfg01	219	SAEvm01	356	SAEma09	446	SAEad14
19	SAEfv01	221	SAEev03	357	SAEpr19	450	SAEpc25
22	SAEgg01	222	SAEvm2	358	SAEtp04	451	SAEec14
23	SAEgr01	223	SAEvr06	359	SAEdp01	452	SAEtq05
27	SAEma11	224	SAEtm14	360	SAEfm04	453	SAEev10
28	SAEma02	226	SAEma04	361	SAEfm05	456	SAEvd02
29	SAEma03	227	SAEma05	362	SAEr05	459	SAEig01
30	SAEpc01	231	SAEds12	363	SAEma10	460	SAEdn03
32	SAEr01	235	SAEds14	364	SAEpr20	462	SAEen07
37	SAEds11	236	SAEpp01	365	SAEad12	463	SAEds20
39	SAEds06	237	SAEpc16	366	SAEen03	464	SAEtm25
42	SAEfl01	238	SAEtm15	367	SAEpr21	474	SAEms02
43	SAEfr01	242	SAEad08	369	SAEfg03	475	SAEpr26
50	SAEpr06	243	SAEva02	370	SAEpw06	476	SAEvm6
51	SAEpr09	249	SAEev04	372	SAEfg04	479	SAEfm09
52	SAEpr01	250	SAEec05	373	SAEid03		
55	SAEpw03	251	SAEpc07	375	SAEr06		
57	SAEtm01	256	SAEpc08	377	SAEpr22	> 479	Warning
64	SAEtm05	261	SAErc02	378	SAEvr07		
68	SAEtp02	262	SAEfg02	379	SAEad13		
69	SAEtq01	264	SAEpc09	380	SAEtm23		
70	SAEtq02	270	SAEds15	383	SAErs02		
71	SAEvl02	272	SAEfm01	384	SAEtm24		
72	SAEvl03	277	SAEtd03	385	SAErs03		
76	SAEvr01	285	SAEsh01	386	SAEpr23		
77	SAEvr03	288	SAEva03	387	SAEpc22		
78	SAEvr02	290	SAErs01	388	SAEfm06		
80	SAEev01	295	SAEpc17	389	SAEfi01		
82	SAEsg01	301	SAEdv01	390	SAEev07		
85	SAEpr03	302	SAEdn02	393	SAEpr24		
96	SAErc01	303	SAEac03	394	SAEr07		
98	SAEtq03	305	SAEpw04	396	SAEfm07		
104	SAEec01	306	SAEct13	397	SAEfm08		
106	SAEpr08	307	SAEde02	398	SAEvr08		
107	SAEpw02	317	SAEfm02	399	SAEvl06		
112	SAEie01	318	SAEr04	400	SAEfi02		
113	SAEad03	319	SAEtm18	401	SAEvl07		
114	SAEva01	320	SAEfq02	403	SAEec08		
115	SAEac01	323	SAEef01	414	SAEaa01		
125	SAEvl01	324	SAEtm21	415	SAEma13		
127	SAEfr02	333	SAEtm20	416	SAEtma01		
130	SAEpr12	334	SAEpc20	429	SAEri01		
131	SAEatf0002	336	SAEfm03	430	SAEpc11		
132	SAEtm02	337	SAEms01	431	SAEpr25		
136	SAEad07	345	SAEpc21	433	SAEfr04		
138	SAEpr04	346	SAEpw05	434	SAEfl04		

Table A14 was constructed of those 2 byte slots in SAE J1939 DA, having numerically scaled content.

A.8   MIL STATUS DISPLAY DETERMINATIONS FOR SECTION 6

Section A.8 shows the MIL_Status Combinations in SAE J1939-73 Table 5 and Table 24 that are allowed for MIL_Status and Flash MIL_Status displays. Allowed data for Section 6 tests is shown in Table A15. Bit patterns other than those given in Table A15 for OFF, ON (Not Flashing), and Not Supported shall not be accepted. On, Flashing, is only referenced in failure criteria.

Below, common phrases in SAE J1939-84 criteria are described in terms of the values allowed in Table A15. The most common phrases are "Does not report MIL Off" and "Does not report MIL Off or not Supported." "Does not report MIL on" is less common: In 00b, 11b below, the first binary value 00b is the value defined for MIL status, and 11b (the second binary value) is the value defined for the "Flash MIL status" SP.

"Do(es) not report MIL off" … This criterion according to Table A15 allows 2 sets of values:

1.   00b, 11b is the preferred encoding for off.

2.   00b, 00b is the alternate coding for off and is to be accepted with a warning message in substitution for 00b, 11b wherever MIL off is accepted (6.1.15.3 defines this explicitly once, but it is implied for all other locations by the footnote to Table A15).

"Does not report Mil off or not supported" … These criteria allow three sets of values:

1.   00b, 11b is the preferred encoding for off.

2.   00b, 00b is the alternate coding for off and is to be accepted with a warning.

3.   11b, 11b is the value allowed for not supported (or not available, as defined in SAE J1939-71).

"No ECU Reports MIL on" … One ECU shall provide:

1.   01b, 11b which denotes on and not flashing in SAE J1939-73 Table 5.

"Does not report MIL on" … This criterion allows a single of values according to Table 9:

1.   01b, 11b which denotes on and not flashing in SAE J1939-73 Table 5.

Table A15 - MIL status and flash MIL status allowed values for Section 6 tests

Section 6 MIL Lamp Status Description	Allowed SPN 1213, 4113 Bit Pattern	Allowed SPN 3038, 4117 Bit Pattern	Notes
OFF	00b	00b	00b was added for an ECU manufacturer's request to harmonize to a common default data value.
		11b	
ON	01b	11b	Not flashing
Not Available	11b	11b	Reserved values in SAE J1939-73 Table 5 should not be used
On, Flashing	01b	00b (1 Hz)	These combinations are not practical to positively demonstrate in Section 6, and only used as failure criteria.
		01b (2 Hz)	
Not Supported	11b	11b	Used by non-OBD ECUs

Notes:

- Warn if the value pair (00b, 00b) is used for MIL Status = Off.

- The values provided for ON and OFF preclude the possibility that the MIL is flashing.

- Value pair (01b, 10_b) in Table 5 of SAE J1939-73 designates the Short MI for Euro VI. This value shall not be substituted for (01b, 11b) for ARB's non-discriminatory MI requirement in 13 CCR 1971.1 (d).

Likewise, (00b, 10_b) which was defined for WWH OBD modeled regulations is not allowed for off.

The data in Table A15 is condensed from the general content of SAE J1939-73 Table 5 as shown below:

From SAE J1939-73 Table 5, MIL LAMP Definitions for All Regulations:

Possible Commanded Conditions		Required Lamp Output Operation
Lamp SP: 1213	Flash SP: 3038	Interpretation for HD OBD and Euro VI
00b	00b	Off
00b	01b	Off
00b	10b	Off, class C not active
00b	11b	Off
01b	00b	On, slow flash (1 Hz)
01b	01b	On, fast flash (2 Hz)
01b	10b	Off, class C active
01b	11b	On, don't flash
10b	00b	Short MI not active
10b	01b	Short MI active
10b	10b	SAE reserved
10b	11b	SAE reserved
11b	00b	SAE reserved
11b	01b	SAE reserved
11b	10b	SAE reserved
11b	11b	Don't Care

A.9   SIGNAL CHART FOR MIL ON TIME AND TIME SINCE CODE CLEAR IN SECTION 6 TESTS.

The signal chart (Figure A1) shows the MIL on Time and Time Since Code Clear signals as a function of the 12 test parts in Section 6. The time spent in a Key OFF, Key On Engine Off, and an Engine Running condition is shown by the Engine Status Line. Note how the Key Off engine status is telegraphed to the Time Since Code Clear (Time SCC) and Time with MIL On signals. The blue areas show how an ignition key definition for Time SCC differs from an Engine Running definition of time SCC.

Signal Chart for Time with Mil ON and Time Since Code Clear Provided in SAE J1939-73 DM21
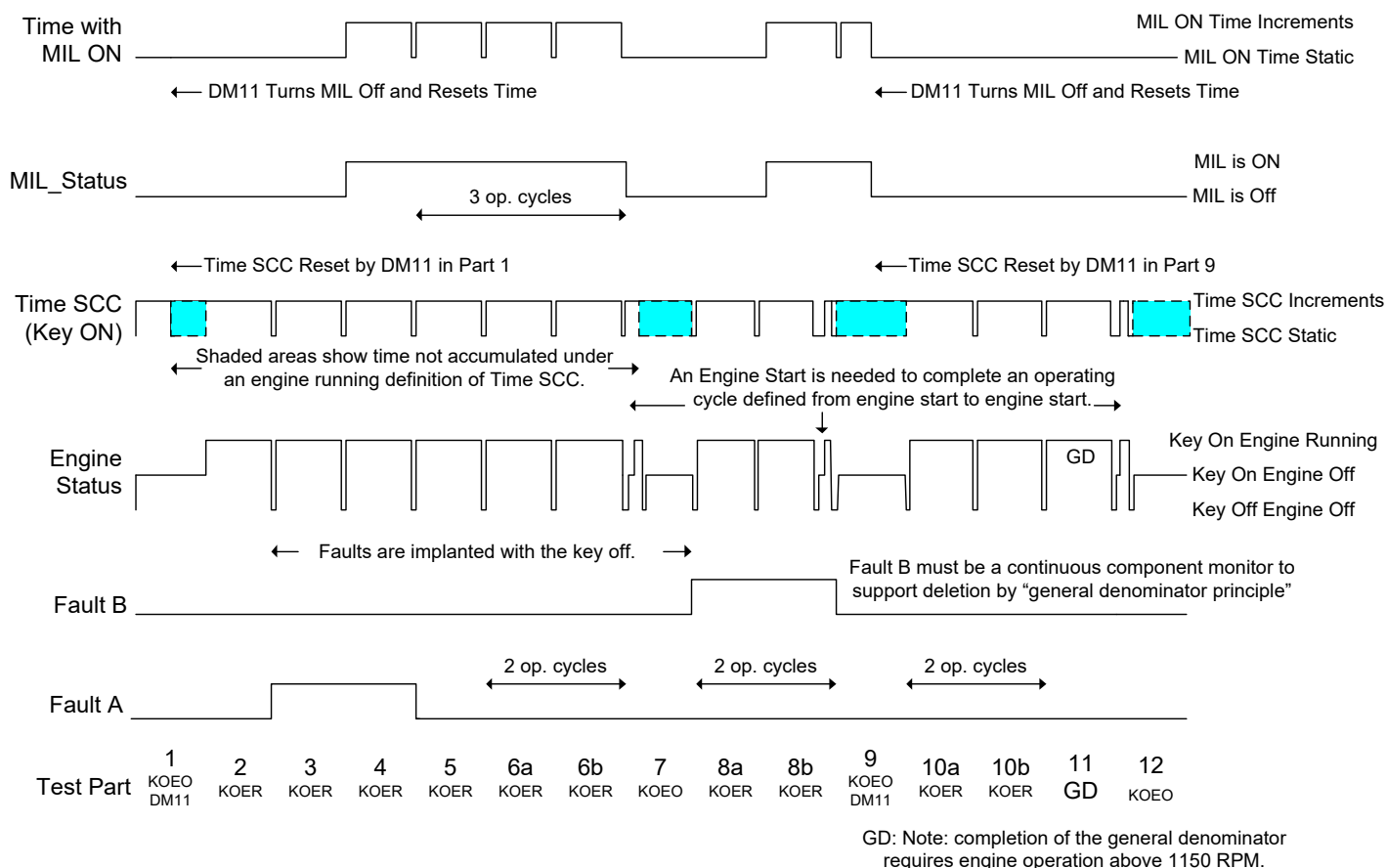
Figure A1 - Signal chart for time with MIL-ON and time since code clear provided in SAE J1939-73 DM21

A.10   ASYMMETRIC PGN SUPPORT EXAMPLE CRITERIA.

For PGs and their SPNs listed in Appendix H of SAE J1939-73, only one ECU is required to respond in order to comply with an individual communication requirement in 13 CCR 1971.1 (h). There are, however, more ways to partition functions in HD OBD systems, than can readily be enumerated here. As a consequence, distributed or partitioned HD OBD systems will not support all available data in each ECU, and support for given PGs can be asymmetric across the HD OBD ECUs available to pins C and D of SAE J1939-13 diagnostic connector.

Tests that are sensitive to asymmetric support follow the general pattern like that given below in the example for DMxx below:

6.x.y DMxx: DMxx Title

6.x.y.1 Actions:

a.   Global DMxx [send Request (PGN 59904) using PGN bbbbb (SPNs …)].

6.x.y.2 Fail Criteria:

a.   Fail if any ECU reports improper positive response criterion.

b.   Fail if any ECU reports improper negative response criterion.

c.   Fail if no ECU provides DMxx.

6.x.y.3 Actions2:

a.   DS DMxx to each OBD ECU.

6.x.y.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.

In the example, at least one response is guaranteed by the global request failure criteria element:

a.   Fail if no ECU provides DMxx.

In some cases, the criteria represented by a and b may themselves assure that at least one response was provided and specific criterion like c is not provided.

Where failure criteria need to reflect different conditions among OBD ECUs, the individual criterion is qualified with information specific to the correct response relevant to test y of part x.

Any ECU which improperly chooses to support only a destination specific request and not the global request is captured by:

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

This criterion assures that an OBD ECU provides the proper negative response defined in SAE J1939-21, when directly queried for a given PG.

Queries that use only the destination specific form of address have no global responses. Here the failure criteria is modeled as:

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

APPENDIX B - TEST REPORT EXAMPLES

Appendix B displays report format examples for software implementations of J1939-84 test procedures. Table B1 shows alternate test summary reports. Table B2 shows a test log. Automated reports shall clearly identify the configuration tested for the information displays available on the data link.

B.1   TEST SUMMARY REPORT EXAMPLES

Table B1 - Example test summary report for HD OBD

Test Summary Report: SAE J1939-84 HD OBD Scan Tool Test

Date: MM/DD/YYYY Time: HH:MM:SS

Vehicle Identification

VINMFGABCDEFGH123456

Source Addr.00 Function 0 Engine
CAL ID: 1xxxxxxxxxxxxxx   2xxxxxxxxxxxxxx   3xxxxxxxxxxxxxx
          4xxxxxxxxxxxxxx   5xxxxxxxxxxxxxx   6xxxxxxxxxxxxxx
CVN   1xxxxxxx   2xxxxxxx   3xxxxxxx
          4xxxxxxxx   5xxxxxxxx   6xxxxxxx

ESN xxxxxxxxxxxxxxxx MAKE xxxxx MODEL xxxxxxxxxxxxx
SOFTWARE ID
ECU Serial Number

Source Addr.X2 Function XX Function Name
CAL ID: 1xxxxxxxxxxxxxx   2xxxxxxxxxxxxxx   3xxxxxxxxxxxxxx
          4xxxxxxxxxxxxxx   5xxxxxxxxxxxxxx   6xxxxxxxxxxxxxx
CVN   1xxxxxxx   2xxxxxxx   3xxxxxxx
          4xxxxxxxx   5xxxxxxxx   6xxxxxxx

SN xxxxxxxxxxxxxxxx MAKE xxxxx MODEL xxxxxxxxxxxxx
SOFTWARE ID
ECU Serial Number

Section 6 Part	Part Title	Summary Result
1	Key On Engine Off - Data Collection	Pass
2	Engine Running - Data Collection	Pass
3	Engine Running - Test Pending Fault A	Pass
4	Engine Running - Test Confirmed Fault A	Pass
5	Engine Running - Correct Fault A First Trip	Pass
6	Engine Running - Complete Fault A Three Cycle Countdown	Pass
7	Key On Engine Off - Verify DM23 Transition	Pass
8	Engine Running - Verify Fault B for General Denominator Demonstration.	Pass
9	Key On Engine Off - Verify Deletion of Fault B with DM11.	Pass
10	Engine Running - Prime Diagnostic Executive for General Denominator Demonstration	Pass
11	Engine Running - Exercise General Denominator	Pass
12	Key On Engine Off - Verify DM28 Deletion of Fault B	Pass

Table B2 - Example summary detail report for test

Test Summary Report: SAE J1939-84 HD OBD Scan Tool Test

Date: MM/DD/YYYY Time: HH:MM:SS

Vehicle Identification

VINMFGABCDEFGH123456
CAL ID:	1xxxxxxxxxxxxxx	2xxxxxxxxxxxxxx	3xxxxxxxxxxxxxx
	4xxxxxxxxxxxxxx	5xxxxxxxxxxxxxx	6xxxxxxxxxxxxxx
CVN	1xxxxxx	2xxxxxx	3xxxxxxx
	4xxxxxxxx	5xxxxxxx	6xxxxxxx

ESN xxxxxxxxxxxxxxxx MAKE xxxxx MODEL xxxxxxxxxxxxx
SOFTWARE ID
ECU Serial Number

Section 6 Part	Part Title			Result
1	Key On Engine Off - Data Collection			FAIL
	Step	Step Title	Result	Summary Failure Data
	2	No Active Faults	Fail	DM1 SA 11 SPN xxxxx FMI xxx
	24	DM34 Support	Warn	DM34 NACK PGN xxxxx DATA
2	Engine Running - Data Collection			Pass
3	Engine Running - Test Pending Fault A			Pass
4	Engine Running - Test Confirmed Fault A			Pass
5	Engine Running - Correct Fault A First Trip			Pass
6	Engine Running - Complete Fault A Three Cycle Countdown			Pass
7	Key On Engine Off - Verify DM23 Transition			Pass
8	Engine Running - Verify Fault B for General Denominator Demonstration.			Pass
9	Key On Engine Off - Verify Deletion of Fault B with DM11.			Pass
10	Engine Running - Prime Diagnostic Executive for General Denominator Demonstration			Pass
11	Engine Running - Exercise General Denominator			Pass
12	Key On Engine Off - Verify DM28 Deletion of Fault B			Pass

B.2   TEST LOG EXAMPLES

Table B3 - Example HD OBD test log

Test Log: SAE J1939-84 HD OBD Scan Tool Test

Date: MM/DD/YYYY Time: HH:MM:SS

Connection Speed: 500 kbps

Vehicle Identification

VINMFGABCDEFGH123456
CAL ID: 1xxxxxxxxxxxxxx   2xxxxxxxxxxxxxx   3xxxxxxxxxxxxxx
           4xxxxxxxxxxxxxx   5xxxxxxxxxxxxxx   6xxxxxxxxxxxxxx
CVN   1xxxxxxx   2xxxxxxx   3xxxxxxx
           4xxxxxxxx   5xxxxxxxx   6xxxxxx

ESN xxxxxxxxxxxxxxxx MAKE xxxxx MODEL xxxxxxxxxxxxx
SOFTWARE ID xxxxxx
ECU Serial Number xxxxxxxxx

Time Stamp:CAN ID DATA

Part 1 Test 2 [Test Name]

2345.666 666   18xxxxF9   XX XX XX XX XX XX XX [Request PGN xxxxxx]
2345.777 777   18xxxx00   XX XX XX XX XX XX XX

Part 5 Test 2 [Test Name]

5678.666 666   18xxFFF9   XX XX XX XX XX XX XX [Request PGN xxxxxx]
5678.777 777   18xxFF00   XX XX XX XX XX XX XX [TP.BAM]
5678.787 777   18xxFF00   XX XX XX XX XX XX XX
5678.797 777   18xxFF00   XX XX XX XX XX XX XX
5678.807 777   18xxFF00   XX XX XX XX XX XX XX

Part 5 Test 12 [Test Name]

6789.666 666   18xx00F9   XX XX XX XX XX XX XX [Request PGN xxxxxx]
6789.777 777   18xxF900   XX XX XX XX XX XX XX [TP.RTS]
6789.787 777   18xx00F9   XX XX XX XX XX XX XX [TP.CTS]
6789.787 777   18xxF900   XX XX XX XX XX XX XX
6789.797 777   18xxF900   XX XX XX XX XX XX XX
6789.807 777   18xxF900   XX XX XX XX XX XX XX