
# Specifications of Remote OBD Systems for Use in CARB's Heavy-Duty Inspection and Maintenance (HD I/M) Program

Ehsan Majd, Ph.D.
Air Pollution Specialist, Mobile Source Control Division

HD I/M Workgroup Meeting
November 16, 2020

# Outline

- Introduction
- Purpose of the HD I/M Remote OBD (ROBD) specification document
- ROBD submission options in HD I/M
- High-Level functionalities of ROBD systems
- General specifications of ROBD systems
- Major specifications of ROBD systems
- Next steps
- Open discussion

# Outline

- Introduction
- Purpose of the HD I/M Remote OBD (ROBD) specification document
- ROBD submission options in HD I/M
- High-Level functionalities of ROBD systems
- General specifications of ROBD systems
- Major specifications of ROBD systems
- Next steps
- Open discussion

# Introduction

- Today's meeting is our third public discussion regarding development of OBD tool specifications for HD I/M
- Main topics discussed in previous public meetings on this issue:
  1) November 2019; CARB's proposed OBD data requirement for demonstrating compliance with HD I/M
  2) July 2020; CARB's proposed high-level characteristics of different OBD data submission options in HD I/M

# Outline

- Introduction
- Purpose of the HD I/M Remote OBD (ROBD) specification document
- ROBD submission options in HD I/M
- High-Level functionalities of ROBD systems
- General specifications of ROBD systems
- Major specifications of ROBD systems
- Next steps
- Open discussion

# HD I/M Remote OBD (ROBD) Specification Document

- Purpose: To communicate specifications for ROBD testing devices to be used to demonstrate vehicle compliance with the HD I/M program
- Intended Audience: Heavy-duty engine original equipment manufacturers (OEMs), OBD scan tool manufacturers, and fleet telematics companies who will design and develop hardware, firmware, and software that will be utilized to submit vehicle OBD test data as part of CARB's HD I/M program

# Outline

- Introduction
- Purpose of the HD I/M Remote OBD (ROBD) specification document
- ROBD submission options in HD I/M
- High-Level functionalities of ROBD systems
- General specifications of ROBD systems
- Major specifications of ROBD systems
- Next steps
- Open discussion

# Proposed Remote OBD Submission Options

1) Certified telematics vendors:
   - CARB certified vendors using continuously connected tools that collect and submit OBD compliance data to CARB
2) HD I/M approved testers:
   - Trained testers using certified non-continuous testing tools (i.e., certified testing dongles) to collect and submit OBD compliance data to CARB
3) Quick stop testing locations throughout the state:
   - Designated locations throughout the state where operators can drive up and use certified non-continuous testing tools to collect and submit OBD compliance data to CARB

# Types of ROBD Submission Options (Tools) in HD I/M

- Continuously connected remote OBD (CC-ROBD)
  - Installed exclusively on one vehicle (either through a dedicated tool developed to meet the HD I/M requirements, or an already-installed telematics/fleet management/ELD tool with modified firmware)
  - Continuously connected 24/7
- Non-continuously connected remote OBD (NCC-ROBD)
  - Designed for use on multiple vehicles
  - Developed to meet the HD I/M requirements by obtaining a snapshot of a vehicle's OBD data and sending to CARB's database

CARB

# Outline

- Introduction
- Purpose of the HD I/M Remote OBD (ROBD) specification document
- ROBD submission options in HD I/M
- High-Level functionalities of ROBD systems
- General specifications of ROBD systems
- Major specifications of ROBD systems
- Next steps
- Open discussion

# High-Level Functionalities of ROBD Systems in HD I/M

- ROBD systems shall be capable of performing the following tasks:
  1) Establishing connection with vehicle and verifying HD OBD/OBD II support
  2) Collecting the required OBD data
  3) Submitting data securely via a standardized format to the CARB HD I/M database
- Additional tasks, specific to CC-ROBD systems:
  4) Checking for the “OBD key events” and submitting the required OBD data upon detecting a key event.
- CC-ROBD tools would only have to meet the SAE protocol of the vehicle they are attached to, whereas NCC-tools shall meet all relevant SAE protocols within the program (a one tool fits all concept).

# Outline

- Introduction
- Purpose of the HD I/M Remote OBD (ROBD) specification document
- ROBD submission options in HD I/M
- High-Level functionalities of ROBD systems
- General specifications of ROBD systems
- Major specifications of ROBD systems
- Next steps
- Open discussion

CARB

# General Specifications of ROBD Systems in HD I/M

- ROBD tools shall meet these general requirements:
  - Not to interfere with the normal operation of the vehicle
  - Be capable of receiving multiple responses when requesting information (either multiple controllers responding to a request or a controller responding multiple times to a request)
  - Refrain from sending a code clear command
  - Execute all its tasks automatically without any human interaction

# Outline

- Introduction
- Purpose of the HD I/M Remote OBD (ROBD) specification document
- ROBD submission options in HD I/M
- High-Level functionalities of ROBD systems
- General specifications of ROBD systems
- Major specifications of ROBD systems
- Next steps
- Open discussion

# Major Specifications of ROBD Systems in HD I/M

1) Diagnostics connector
2) Communication with vehicle
3) Collecting vehicle OBD data
4) Checking for OBD key events (specific to CC-ROBD systems)
5) Formatting the collected data
6) Transmitting data to CARB HD I/M database

# 1) Major Specifications of Diagnostic Connector (S.5.1)

- CC-ROBD tools may be installed permanently (hard-wired into the vehicle wire harness) or semi-permanently (plugged into an available OBD port in vehicle).
- NCC-ROBD tools shall be capable of mating to both the connectors defined in SAE J1962/ISO 15031-3 and to the SAE J1939-13 connector.
- ROBD tools shall follow the requirements for communication rate (250 or 500 kilobits/sec), as specified in CARB HD OBD Regulation (CCR Title 13, Section 1971.1).

# 2) Major Specifications for ROBD Tool-Vehicle Communication (S.5.2)

The SAE J1939 ROBD tools shall:

- Meet all applicable standardized communication requirements (e.g., SAE J1939-84, 21, 71, 73, 81, and 3)
- Perform proper initialization comprised of the following steps prior to requesting diagnostic services from any ECU:
  1) Performing address claim as specified in SAE J1939-81
  2) Verifying vehicle's support of HD OBD via sending a DM5 request
- Identify the available data by sending specific requests for DM24 message to all HD OBD compliant ECUs following a successful initialization
- Refrain from requesting data that is routinely broadcast on the network

# 2) Major Specifications for ROBD Tool-Vehicle Communication (cont.)

The SAE J1979 ROBD tools shall:

- Meet all applicable standardized communication requirements (e.g., ISO 15765-4, SAE J1978/ISO 15031-4, SAE J1699-2 and -3, and SAE J3005-1).
- Perform initialization sequence (specified in ISO 15765-4) before sending diagnostic requests.
- Identify the available data by recording all positive responses, including CAN source (i.e. specific ECU), to a Mode $01 PID $00, $20, $40, etc. requests sent during initialization.
- Conduct analogous scans for available Monitor IDs (MIDs) in Mode $06 and InfoTypes in Mode $09.

# 3) Major Specifications for Collecting Vehicle OBD Data (S.5.3)

- ROBD tools shall be capable of collecting all the data required by CARB HD OBD regulation (CCR Title 13, Section 1971.1) and specified in sections (h)(4) and (h)(5).
- ROBD systems shall supplement the collected OBD data with additional information of the tested vehicle, ROBD tools used for collecting data, and date/time of the data collection.

# 3) Major Specifications for Collecting Vehicle OBD Data (cont.)

| Data Type | Corresponding Section in CARB HD OBD Regulation (CCR Title 13, Section 1971.1) | Relevant request message(s) in each OBD protocol | | Comments |
|---|---|---|---|---|
| | | J1939 | J1979 | |
| **Readiness status of all OBD monitors listed in sections (e) and (g)** | (h)(4.1) | DM5, DM21, DM26 | Mode $01 PID $01 | |
| **all data stream parameters (at least three measurements for each)** | (h)(4.2.2) and (h)(4.2.3) | See SAE J1939DA for PGNs and SPNs | Mode $01, see SAE J1979DA for PIDs | |
| **Freeze frame data** | (h)(4.3) | DM25 | Mode $02 | |
| **Fault codes (active, pending, and permanent)** | (h)(4.4) | DM1, DM6, DM12, DM23, DM28, DM29 | Modes $03, $07, $0A | J1939 OBD tool shall also collect the previously active fault codes |
| **Monitoring support status and test results** | (h)(4.5) | DM24, DM30, DM7 | Mode $06 | |
| **Software calibration ID (Cal-ID)** | (h)(4.6), (h)(4.7) | DM19 | Mode $09 InfoType $04 | |
| **Calibration Verification Number (CVN)** | | | Mode $09 InfoType $06 | |
| **VIN** | (h)(4.8) | PGN: 65260<br>SPN: 237 | Mode $09 InfoType $02 | |
| **Engine serial number** | (h)(4.8) | PGN: 65269<br>SPN: 588 | Mode $09 InfoType $0D | |
| **ECU name** | (h)(4.9) | PGN: 60928<br>SPN:2848 | Mode $09 InfoType $0A | |
| **Monitor in-use performance ratio** | (h)(5.1) | DM20 | Mode $09 InfoType $0B | |
| **Engine run time** | (h)(5.2) | See SAE J1939DA for PGNs and SPNs | Mode $01, see SAE J1979DA for PIDs | |
| **NOx emissions tracking data** | (h)(5.3) | PGN: 64258 | Mode $09 InfoTypes $61 - $76 | For all 2022 and subsequent model year diesel engines |
| **Fuel consumption, run time, and travelled distance** | (h)(5.4) - (h)(5.6) | See SAE J1939DA for PGNs and SPNs | Mode $09 InfoTypes $41 - $49, $50 - $5B | For all 2022 and subsequent model year diesel engines |
| **Engine odometer reading** | (h)(5.8) | See SAE J1939DA for PGNs and SPNs | Mode $09 InfoType $77 | For all 2024 and subsequent model year diesel engines |

# 4) Major Specifications for OBD Key Event Check (S.5.4)

- Specific to CC-ROBD systems
- Performed within 5 minutes of every engine start
- CC-ROBD systems shall be capable of running both “basic” and “full” checks.

1) Full OBD key event check
    i. Loss of power between vehicle and CC-ROBD tool
    ii. Change in MIL status
    iii. Change in E-VIN, ECU ID’s, CAL ID’s and CVN’s
    iv. Change in readiness profile of the OBD monitors from “Ready” to “Not Ready
    v. Entering/exiting California (optional parameter)

2) Basic OBD key event check
    - Only the tool power and the optional CA entry/exit check

# 4) Major Specifications for OBD Key Event Check (cont.)

- Vendor may assign the key event detection logics to their proprietary database or the CC-ROBD tool.
- CC-ROBD systems shall automatically submit the required OBD data when 90 days have passed since the last data submission.
- Optional GPS-based CA entry/exit check
  - Activated by vendor after receiving consent from the vehicle owner
  - CA entry/exit since the last engine start detected via CA state geofence parameters
  - Full data submission as specified by CARB upon entering CA
  - Inform CARB HD I/M database in specified format when leaving CA
  - Exempt from the 90-day data submission requirement and key event checks while operating outside CA

# 5) Major Specifications for Formatting the Collected Data (S.5.5)

- File structure: The file shall consist of two sections;
  1) Data header
     - Vehicle (VIN, OBD protocol, odometer reading)
     - OBD tool (name, serial number, firmware number)
     - Data collection/submission (record ID, data collection date/time)
     - Detected OBD key events (event identifier code, CA exit) (specific to CC-ROBD systems)
  2) CAN Bus data
     - Timestamp in milliseconds
     - Message type (to differentiate sent/received messages between ROBD tool and vehicle)
     - Data portion of the CAN Bus message in hexadecimal format
- File extension: The file shall be a standard ASCII text file with a ".csv " extension.

# 6) Major Specifications for Data Transmission to HD I/M Database (S.5.6)

- Data submission to CARB HD I/M database only allowed for registered ROBD systems from certified vendors (authenticity verified via vendor-supplied client-side Secure Sockets Layer (SSL) certificate)
- Data encryption via a CARB-provided public key prior to submission
- Submission of the encrypted data files to HD I/M database upon internet connection availability (satellite, cellular network, Wi-Fi, hot spot, etc.)
- Enough internal storage on the OBD tool to store the retrieved data that have not been submitted due to unavailable internet connection.
- Data not to be altered/tampered with during or prior to submission to HD I/M database

# Outline

- Introduction
- Purpose of the HD I/M Remote OBD (ROBD) specification document
- ROBD submission options in HD I/M
- High-Level functionalities of ROBD systems
- General specifications of ROBD systems
- Major specifications of ROBD systems
- Next steps
- Open discussion

# Next Steps

- Revise the developed specifications based on feedback received from the OBD community
  - Written and/or oral feedback requested by January 15, 2021
  - Parties can reach out to CARB staff contact for individual meeting requests if interested
- CARB seeks participation from interested telematics vendors, OEMs, and fleets to test and validate the specifications.
- Future workgroup on device specifications development following incorporation of stakeholder feedback (≈ Early Spring 2021)

# Thank You!

## *Open Discussion*


**CARB Staff Contact:**
Ehsan Majd, Ph.D.
Mobile Source Control Division
Email: ehsan.majd@arb.ca.gov


CARB HD I/M webpage: https://ww2.arb.ca.gov/our-work/programs/heavy-duty-inspection-and-maintenance-program

CARB