



On-Board Diagnostics Symposium-Europe

March 12-14, 2024 | Amsterdam, Netherlands

Regulatory Update: CARB Heavy-Duty On-Board Diagnostics (HD OBD)

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California Air Resources Board

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Agenda

- New HD OBD Requirements for 2024 and 2025 Model Years (MY)
- Omnibus Rulemaking
- Off-Road OBD (OR-OBD) Draft Regulatory Proposal
- Clean Truck Check Program Update
- Software Calibration Identification (CALID)/Calibration Verification Number (CVN)
- HD OBD Certification Reminders

CARB Heavy-Duty OBD Regulatory Update



New HD OBD Requirements for 2024MY & 2025MY

New HD OBD 2024MY Requirements



Aging and Data Collection of Diesel Test Engines

Requirement	Description	
California Code of Regulations (CCR) 1971.1 (i)(2.3.4)(A)	<ul style="list-style-type: none">• Must collect emission, deterioration, and performance data from an actual high mileage system (minimum of full useful life)• Submit a plan for system selection, procurement, and data collection	<ul style="list-style-type: none">• Include fuel burn rate, total fuel, and reductant consumed over full useful life• Correlate adaptation/learning parameters between actual full useful life system and accelerated aged engine

New HD OBD 2024MY Requirements



Aging and Data Collection of Diesel Test Engines

Requirement	Description	
CCR 1971.1 (i)(2.3.4)(B)	<ul style="list-style-type: none">Minimum system accelerated aging (hours):<ul style="list-style-type: none">Heavy HD: 2,500Medium HD: 1,063Light HD: 632System consists of an <u>engine</u>, <u>engine emissions controls</u>, and <u>aftertreatment</u>	<ul style="list-style-type: none">Operation at:<ul style="list-style-type: none">Rated horsepowerSpecific load levelsTransient conditionsRegeneration events experienced over full useful lifeThermal cycling events

New HD OBD 2024MY Requirements



Hybrid Components

Requirement	Description	
CCR 1971.1 (g)(3.2.3)	<ul style="list-style-type: none">• Specific Hybrid Comprehensive Component Monitor (CCM) monitoring requirements for the following:<ul style="list-style-type: none">• Energy Storage System (ESS)• Hybrid Thermal Management Systems	<ul style="list-style-type: none">• Regenerative Braking• Drive Motor• Generator• Plug-in Hybrid Electric Vehicle ESS Charger

New HD OBD 2025MY Requirements



Catalyst System Aging and Monitoring

Requirement	Description	
NMHC Converting Catalyst System CCR 1971.1 (e)(5.2.4)(B)	<ul style="list-style-type: none">Representativeness of catalyst aging method to real-world catalyst deteriorationRequirement is for engine families selected for <u>monitoring system demonstration</u>	<ul style="list-style-type: none">Include a timeline for submitting information and dataLocate high mileage and field returned partsSubmit information and data to support manufacturer aging method is representative of real-world catalyst deterioration
NOx Converting Catalyst System CCR 1971.1 (e)(6.2.3)(B)		

CARB Heavy-Duty OBD Regulatory Update



Omnibus Rulemaking

Omnibus Rulemaking

March 20th, 2024 – Planned Omnibus Amendments Workshop

<https://ww2.arb.ca.gov/our-work/programs/heavy-duty-low-nox/heavy-duty-low-nox-meetings-workshops>

- Proposed amendments to implement CARB's commitment to the Clean Truck Partnership
 - Primary commitment is to align with the US EPA 2027 and subsequent model year heavy-duty engine NOx requirements
- OBD-Specific Content
 - Modify real emission assessment logging (REAL) data tracking bins
 - Remove not-to-exceed (NTE) bin and add 2-bin moving average window (2B-MAW) bins

CARB Heavy-Duty OBD Regulatory Update



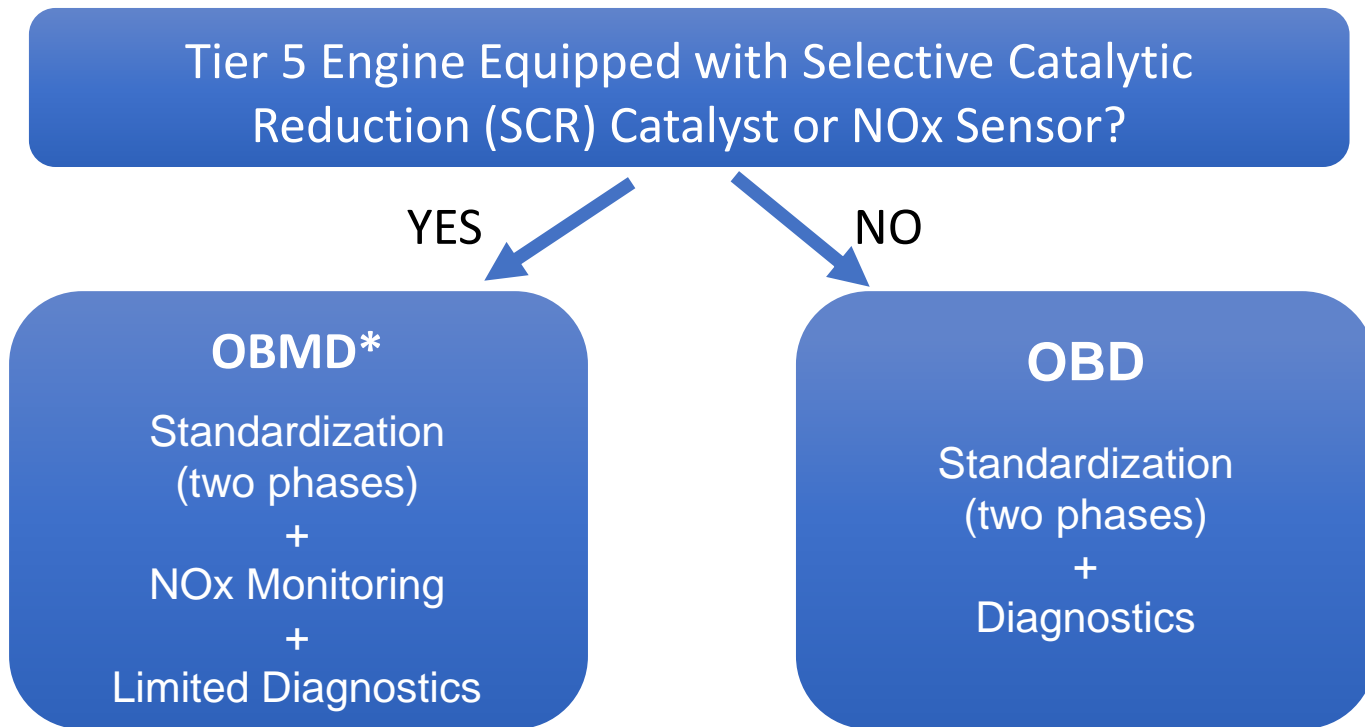
Off-Road OBD (OR-OBD) Draft Regulatory Proposal

OR-OBD Draft Regulatory Proposal

- CARB currently working on draft regulatory proposal for OR-OBD
- Final rulemaking expected for June 2025



OR-OBD System



* OBMD: On Board Monitoring and Diagnostics

Phase 1: Standardization Requirements

Applies to all Tier 5 interim & final engines with electronic control units

- Begins the first model year that a Tier 5 engine is introduced
- Covers engines in all power categories

Elements include:

- Communication to a generic scan tool using SAE J1939 or J1979-2
- Data link connector: consistent with communication standard
- Data stream requirements: emissions-related physical inputs/outputs
- Off-road real emissions assessment logging (OR-REAL) data (SCR-equipped or NOx sensor-equipped engines only)
- CALID and CVN

Phase 2: Standardization Requirements

Applicability:

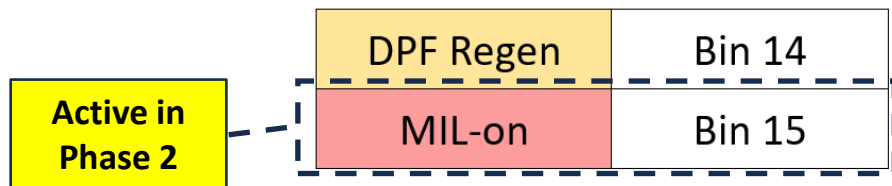
- Phase 2 standardization requirements are in addition to Phase 1
- Electronically controlled Tier 5 final engines, all power categories

Elements include:

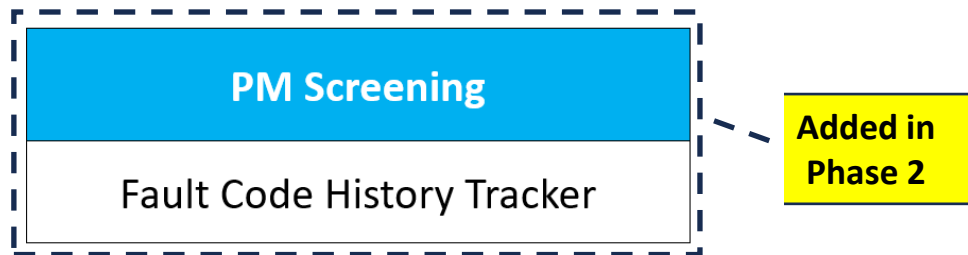
- Standardized fault codes (pending and confirmed)
- Dedicated malfunction indicator light (MIL)
- Test results
- Freeze frame
- Monitor activity data (MAD) – equivalent to supplemental monitor activity data (SMAD), which is currently required for on-road vehicles using SAE J1979-2
- Particulate matter (PM) – related fault code history tracking parameter

OR-REAL Data Tracking: Bin Structure

	Bin 1 Total	SCR Outlet Temperature (deg C)			
		≤ 200	$> 200 \text{ \& } \leq 250$	$> 250 \text{ \& } \leq 400$	> 400
Power (% of rated)	$\leq 25\%$	Bin 2	Bin 3	Bin 4	Bin 5
	$> 25\% \text{ \& } \leq 50\%$	Bin 6	Bin 7	Bin 8	Bin 9
	$> 50\%$	Bin 10	Bin 11	Bin 12	Bin 13



NOx Screening 3B - MAW		
Bin A	Bin B	Bin C

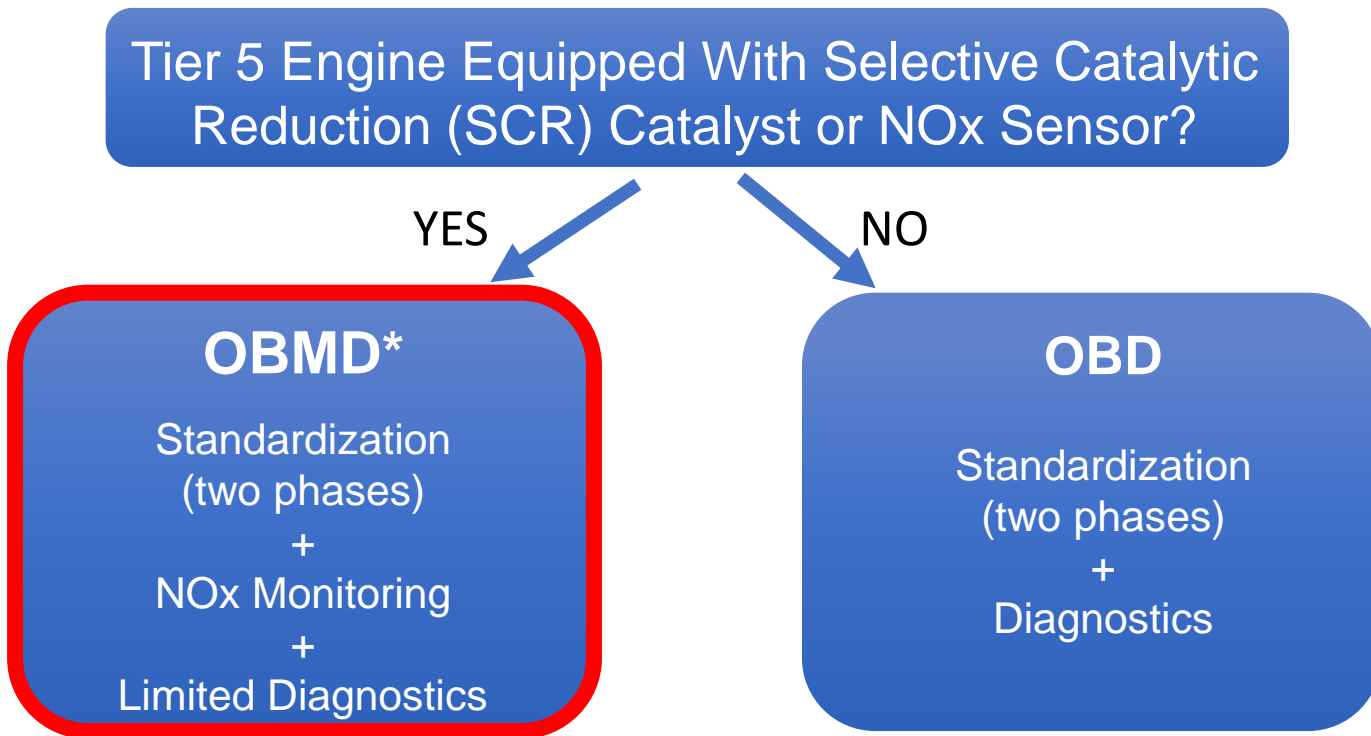


OR-REAL Data Tracking: Parameters and Arrays

Parameter	Active 50 Hour Array ¹ (Bins)		Stored 50 Hour Array ¹ (Bins)		Lifetime Array ¹ (Bins)		Lifetime Engine Activity Array ² (Bins)	
NOx mass – engine out (g)	1-15	-	1-15	-	1-15	-	-	-
NOx mass – tailpipe (g)	1-15	A, B, C	1-15	A, B, C	1-15	A, B, C	-	-
Engine output energy (kWh)	1-15	B, C	1-15	B, C	1-15	B, C	1-15	B, C
Engine Run time (hours)	1-15	A, B, C	1-15	A, B, C	1-15	A, B, C	1-15	A, B, C
Total fuel consumption (liters)	1-15	-	1-15	-	1-15	-	1-15	-

1. Tracks data only when NOx sensors are on.
2. Tracks data over all engine activity (can thus determine amount of activity with no NOx data).

OR-OBD System



* OBMD: On Board Monitoring and Diagnostics

OBMD Concept Overview

OBMD Requirements

- Standardization Requirements (see previous slides)
- OBMD Diagnostic Requirements
 - On-Board Monitoring (OBM) NOx emission threshold diagnostic
 - Tailpipe NOx sensor emission threshold diagnostic
 - PM filter emission threshold diagnostic
 - PM sensor diagnostics
 - CCM requirements

OBMD Concept Overview (cont'd)

OBM NOx Emission Threshold Diagnostic

- Fixed threshold based on 3-Bin Moving Average Window (3B-MAW) bins B and C

OBM NOx Thresholds (g/kW-hr)		
Power	Bin B	Bin C
>56 kW & <560 kW	0.6	0.6
>560 kW*	N/A	1.2

- OBM MIL illumination only required during warranty period

* For mobile machines with SCR (or NOx sensor) and 3.0+ g/kW-hr NOx standards, use twice the emission standard instead.

OBMD Concept Overview (cont'd)

Tailpipe NOx Sensor Emission Threshold Diagnostic

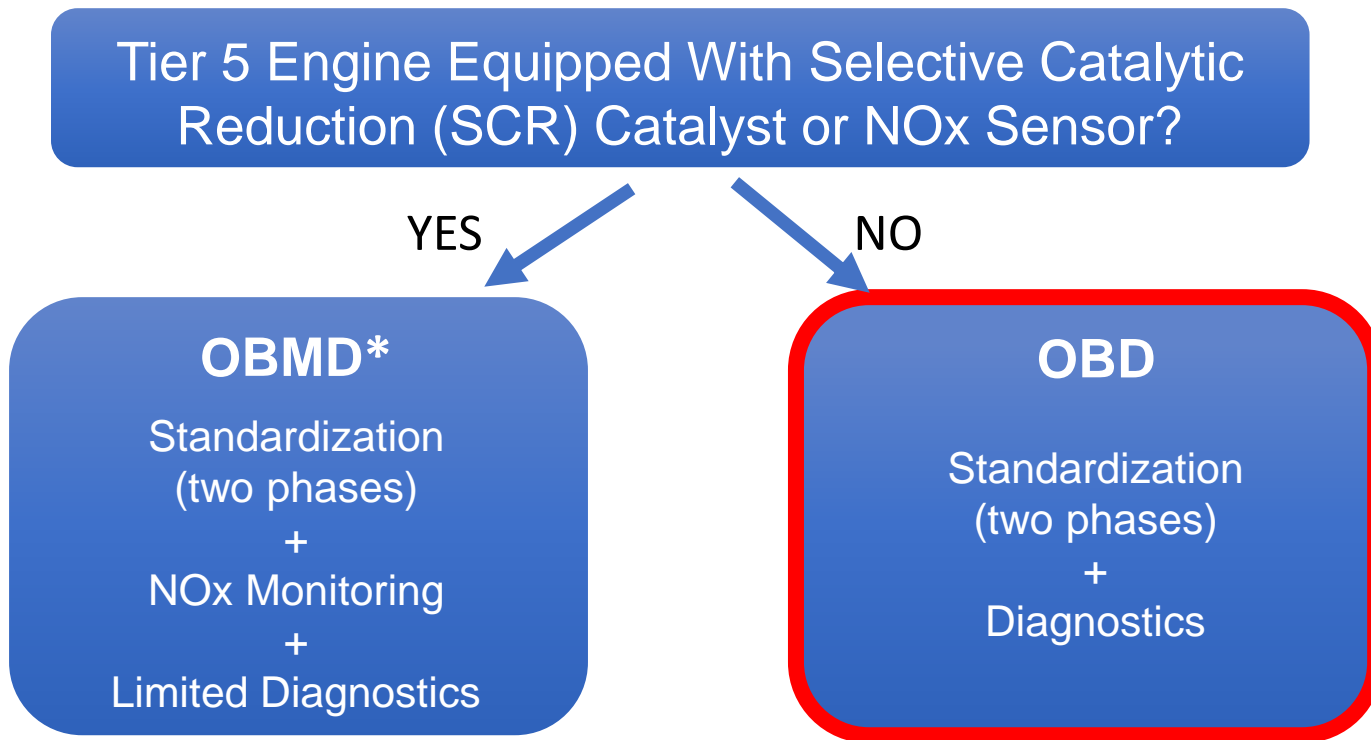
- Performance for OBM (NOx measurement error)
 - Detect malfunction before sensor failure/deterioration (e.g., offset, gain) causes measurement error to exceed **+/- TBD g/kW-hr**
- Circuit Faults
- NOx sensor measurement readiness:
 - Detect when the NOx sensor is inappropriately offline

OBMD Concept Overview (cont'd)

PM Filter Emission Threshold Diagnostic

- Malfunction Criteria
 - Proposing same emission threshold level as on-road HD OBD:
0.04 g/kW-hr
 - On-road HD engine manufacturers have met this requirement using resistive PM sensors since 2016 MY
- PM filter diagnostic requirements will be identical for both OBMD and OBD concepts

OR-OBD System



* OBMD: On Board Monitoring and Diagnostics

OBD Concept Overview

OBD Requirements for Engines without SCR and NOx Sensor

- Standardization Requirements
- Diagnostic Requirements
 - Emission threshold diagnostics for PM filter, exhaust gas recirculation (EGR), and fuel system
 - Diesel oxidation catalyst (DOC) regeneration performance diagnostic
 - PM sensor performance diagnostics
 - CCM requirements

Parent Engines Implementation Plan (Phases 1+ 2 Standardization, OBD/OBMD, PEVE)											
Power Category	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	
< 8 kW	Tier 5 not started yet	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	OBD + Phases 1+2 Standardization + PEVE	OBD + Phases 1+2 Standardization + PEVE	OBD + Phases 1+2 Standardization + PEVE	OBMD + Phases 1+ 2 Standardization + PEVE	OBMD + Phases 1+ 2 Standardization + PEVE	Deficiency fines begin
$8 \leq \text{kW} < 19$											
$19 \leq \text{kW} < 56$											
$56 \leq \text{kW} < 130$											
$130 \leq \text{kW} \leq 560$	Tier 5 not started yet	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	OBD + Phases 1+2 Standardization + PEVE	OBD + Phases 1+2 Standardization + PEVE	OBD + Phases 1+2 Standardization + PEVE	OBMD + Phases 1+ 2 Standardization + PEVE	OBMD + Phases 1+ 2 Standardization + PEVE	Deficiency fines begin
> 560 kW (Gensets)											
>560 kW (Mobile Machines)*											

* For >560 kW (mobile machines), OBD or OBMD depends on emission control system

Child Engines Implementation Plan (Phases 1+ 2 Standardization, OBD/OBMD, PEVE)											
Power Category	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	
< 8 kW	Tier 5 not started yet	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	OBD + Phases 1+2 Standardization + PEVE	OBD + Phases 1+2 Standardization + PEVE	Deficiency fines begin
$8 \leq \text{kW} < 19$											
$19 \leq \text{kW} < 56$											
$56 \leq \text{kW} < 130$											
$130 \leq \text{kW} \leq 560$	Tier 5 not started yet	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	Tier 5 Emission Cert + Phase 1 Standardization	OBD + Phases 1+2 Standardization + PEVE	OBD + Phases 1+2 Standardization + PEVE	Deficiency fines begin
> 560 kW (Gensets)											
>560 kW (Mobile Machines)*											

Tier 5 not started yet
Tier 5 Emission Cert + Phase 1 Standardization
OBD + Phases 1+2 Standardization + PEVE
OBMD + Phases 1+ 2 Standardization + PEVE
Deficiency fines begin



Clean Truck Check Program Update

Clean Truck Check Program Update

Starting January 2023

High-emitter vehicle screening using Portable Emission Acquisition System (PEAQS) and follow up compliance testing begins.

Flagged vehicles required to submit passing compliance test within 30 days of notification.

Starting October 2023

Initial vehicle reporting and payment of 2023 compliance fees in Clean Truck Check-Vehicle Inspection System (CTC-VIS) by 1/31/2024.

Starting in 2024

Payment of 2024 compliance fees in CTC-VIS for July through December 2024 compliance deadlines.

DMV registration blocks enforced.

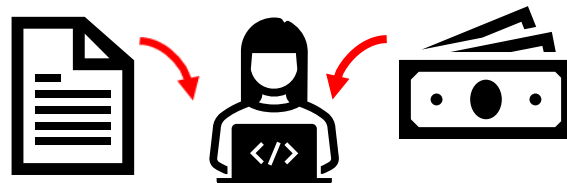
Periodic testing requirements begin.

Periodic Smoke Inspection Program (PSIP) sunsets.

Clean Truck Check Program Update (cont'd)

January 31, 2024 Deadline: Initial Reporting and Compliance Fees

- Vehicle owners are now required to report fleet and vehicle information and pay a 2023 \$30/vehicle annual compliance fee for the first time in CTC-VIS
- High-emitter screening continues augmented with automated license plate recognition cameras to assist with enforcement, particularly on vehicles registered outside of California.
 - CARB also coordinates enforcement efforts with California Highway Patrol and other state agencies to enhance enforcement efforts



Clean Truck Check Program Update (cont'd)

2024: Clean Truck Check Program Periodic Testing Requirements

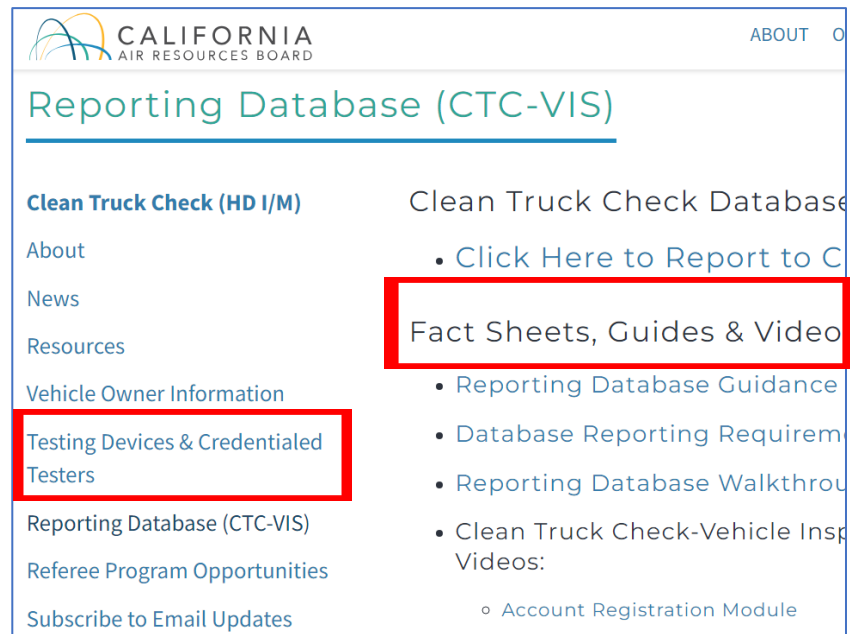
- Periodic vehicle testing requirements start later this year
 - PSIP sunsets when periodic testing begins
- In 2025, vehicles will be subject to semiannual compliance testing
 - For most vehicles - two tests each year, one every six months*
 - A passing compliance test will be required to be submitted to CARB within the 90 days before a vehicle's compliance deadline
 - Starting in 2027, testing frequency increases to four times per year** for most OBD-equipped vehicles

*California-registered motorhomes and agricultural vehicles subject to annual testing

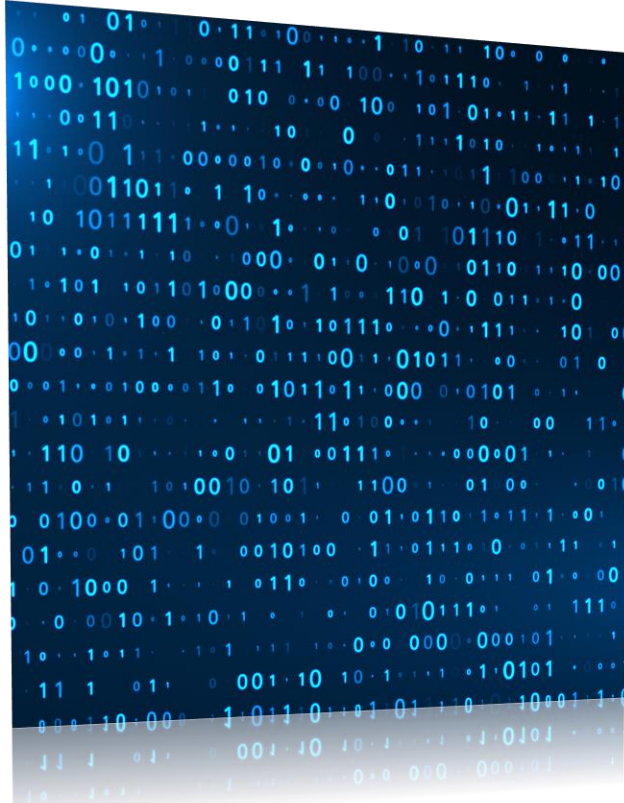
**California-registered motorhomes and agricultural vehicles with OBD still subject to annual testing

Clean Truck Check Resources

- Vehicle owners are required to report vehicles and make annual compliance fee payments in:
 - Clean Truck Check-Vehicle Inspection System (CTC-VIS) reporting database:
<https://cleantruckcheck.arb.ca.gov/>
- Please check out CARB's Clean Truck Check Program page to access certified testing device information, credentialed tester training, fact sheets, and other helpful information:
<https://ww2.arb.ca.gov/our-work/programs/inspection-and-maintenance-program/vehicle-owner-information>
- Have questions? Email the Clean Truck Check team at hdim@arb.ca.gov.



CARB Heavy-Duty OBD Regulatory Update



CALID/CVN

CALID/CVN

- Per CCR 1971.1 (h)(4.7.2): **One CVN shall be made available for each CALID made available**
- Manufacturers must follow a 1:1 CALID and CVN relationship
- Data from the Clean Truck Check Program shows approximately 4% of trucks have multiple CVNs for one CALID
- CARB is currently investigating to determine if it is a tampering, manufacturer design, or scan tool communication issue
- Anticipate further discussions with CARB if investigation points to a manufacturer design issue

CALID/CVN (cont'd)

SAE J1939 Protocol		
Number of CVN(s)	Number of CALID(s)	Percentage of CALID(s)
1	3142	95.0%
2	112	3.4%
3	31	0.9%
4	7	0.2%
5	4	0.1%
6	3	0.1%
7	3	0.1%
8	2	0.1%
9	1	0.0%
10	1	0.0%
11	1	0.0%
14	1	0.0%

SAE J1979 Protocol		
Number of CVN(s)	Number of CALID(s)	Percentage of CALID(s)
1	1818	97.2%
2	44	2.4%
3	5	0.3%
4	1	0.1%
7	1	0.1%
8	1	0.1%

For 5,178 CALIDs, 4.2% have more than one CVN

CARB Heavy-Duty OBD Regulatory Update



HD OBD Certification Reminders

HD OBD Application Reminders

Representative Engines

- CCR 1971.1(j)(1.1)

The executive officer shall approve the engine as representative if the engine possesses the most stringent exhaust emission standards and OBD monitoring requirements and **covers all the emission control devices for the engines covered** by the submitted documentation

- If the engine chosen to represent all others in the OBD group does not contain all emission control devices present within the OBD group, the application should include **all** missing control devices and monitors
- Currently, some manufacturers are only providing the monitors present on the representative engine!

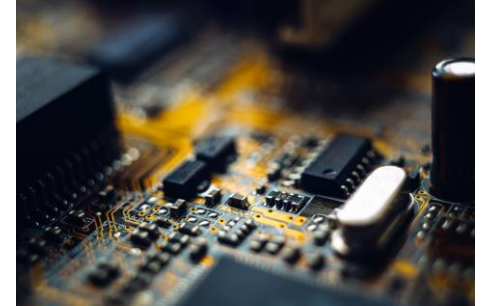
HD OBD Application Reminders (cont'd)

Smart Devices

- OBD application must include a complete written description of monitoring strategies carried out by each smart device

Cover Letter Disclosures

- Specify which SAE J1979 communication standard is being used (e.g., J1979 or J1979-2)
- For 2024 - 2026MY, specify whether the engine families in the application are being certified to the "legacy" engine provisions of 1971.1 (d)(8.4) and 1956.8(a)(2)(C)3
 - 2026MY is pending approval by the Office of Administrative Law



HD OBD Application Reminders (cont'd)

PEVE L3 Submissions

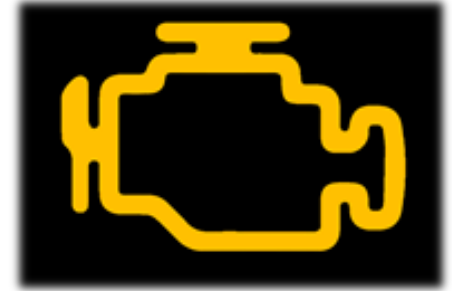
- Friendly reminder to submit your 2023MY+ PEVE L3 submissions!
- ECCD/OBD-120 HD OBD Gasoline PVE(I)(3) Template:
<https://ww2.arb.ca.gov/resources/documents/eccdobd-120-hd-obd-gasoline-peve-l3-template>
- ECCD/OBD-121 HD OBD Diesel PEVE(I)(3) Template:
<https://ww2.arb.ca.gov/resources/documents/eccdobd-121-hd-obd-diesel-peve-l3-template>
- Please note, that the in-use rate-based data tab is mandatory to use. The other tabs (e.g., REAL NOx Data, REAL Greenhouse Gas (GHG) Data, OBD Snapshot Data, etc.) are optional, but highly recommended.

Acknowledgments

- Ashton Hashemi
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Contact Info

- Official CARB documents available from
 - <https://ww2.arb.ca.gov/>
- Direct link to OBD webpage
 - <https://ww2.arb.ca.gov/our-work/programs/obd>



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