

# Developing Tools to Quickly Find Potentially High Emitting Heavy-Duty Vehicles



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**US Environmental Protection Agency, Office of Transportation & Air Quality**  
**National Vehicle and Fuel Emissions Laboratory, Ann Arbor, MI**

# Study Objective

- Study was performed to evaluate commercial (or pre-commercial) tools to “automatically” detect vehicles with potentially high emissions in less than 2-3 minutes
  - EPA wants to better understand the in-use emissions from the diesel fleet since the implementation of the MY2007/2010 regulations.
  - What fraction of the fleet consists of high emitting vehicles, across engine manufacturers and/or vehicle types within the fleet?
  - “Blind” Testing Protocols and analysis was used between scanning tools
- **“Tampered”** – For purpose of this study, means vehicles where the emission control hardware is electronically and/or physically disabled and OBD software functions related to these systems were disabled or otherwise bypassed.
  - Primarily evaluated the exhaust gas recirculation (EGR) system, diesel oxidation catalyst (DOC), diesel particulate filter (DPF), and selective catalytic reduction (SCR) system.

# Study Scope

- Approximately 75 vehicles were evaluated at an auction site in 2023
  - The sample of vehicles tested is not representative of the fleet because efforts were made to select vehicles that included potential tampering
- **Vehicles tested included:**
  - Medium-duty (MD) diesel trucks: (8501-14,000 lbs. GVWR), Model Year (MY) 2007+, OBDII compliant
  - Heavy-duty (HD) diesel trucks: (>14,001 lbs. GVWR), MY 2011+, OBD compliant
  - Variety of types of vehicles: tractors, stake bed, garbage, boom, water, box trucks
  - Mixture of Vehicle and Engine Manufacturers: Volvo, Freightliner, Cummins, Dodge, GM, etc.
  - OBD compliant = OBDII (SAE J1979) or HD OBD (SAE J1939)
- **Reference Tools for gather information:**
  - HEM Data DAWN Mini-Logger (“live” 1-hz data stream)
  - RA Consulting’s SilverScan (“snapshot” of operational data and diagnostics)
  - Diesel Laptops Diesel Decoder (“snapshot” of operational data and diagnostics)

Disclaimer: EPA does not endorse any of these products and is only making the public aware of their existence for possible use.

# Tools Evaluated

- **Diesel Laptops Emissions Delete Detector (EDD) (PocketFleet)**
  - Tested as a pre-commercial tool
  - Currently can scan Cummins, Detroit Diesel and International MaxxForce; future to likely include Paccar, Hino, Mack and Volvo
  - Current version does not work on pickup trucks (Ford, Ram, etc.)
  - Inferred the engine family from information scanned from the OBD port and prompted the user to verify the value
  - Showed Pass/Fail on computer screen
  - Provided PDF of results at conclusion of test
- **HEM Data HD OBD Inspector with TamperDetect**
  - All scanned data uploaded to cloud for 3<sup>rd</sup> party analysis
  - Current version is J1939 capable
  - J1979 (i.e., pickup trucks) development underway

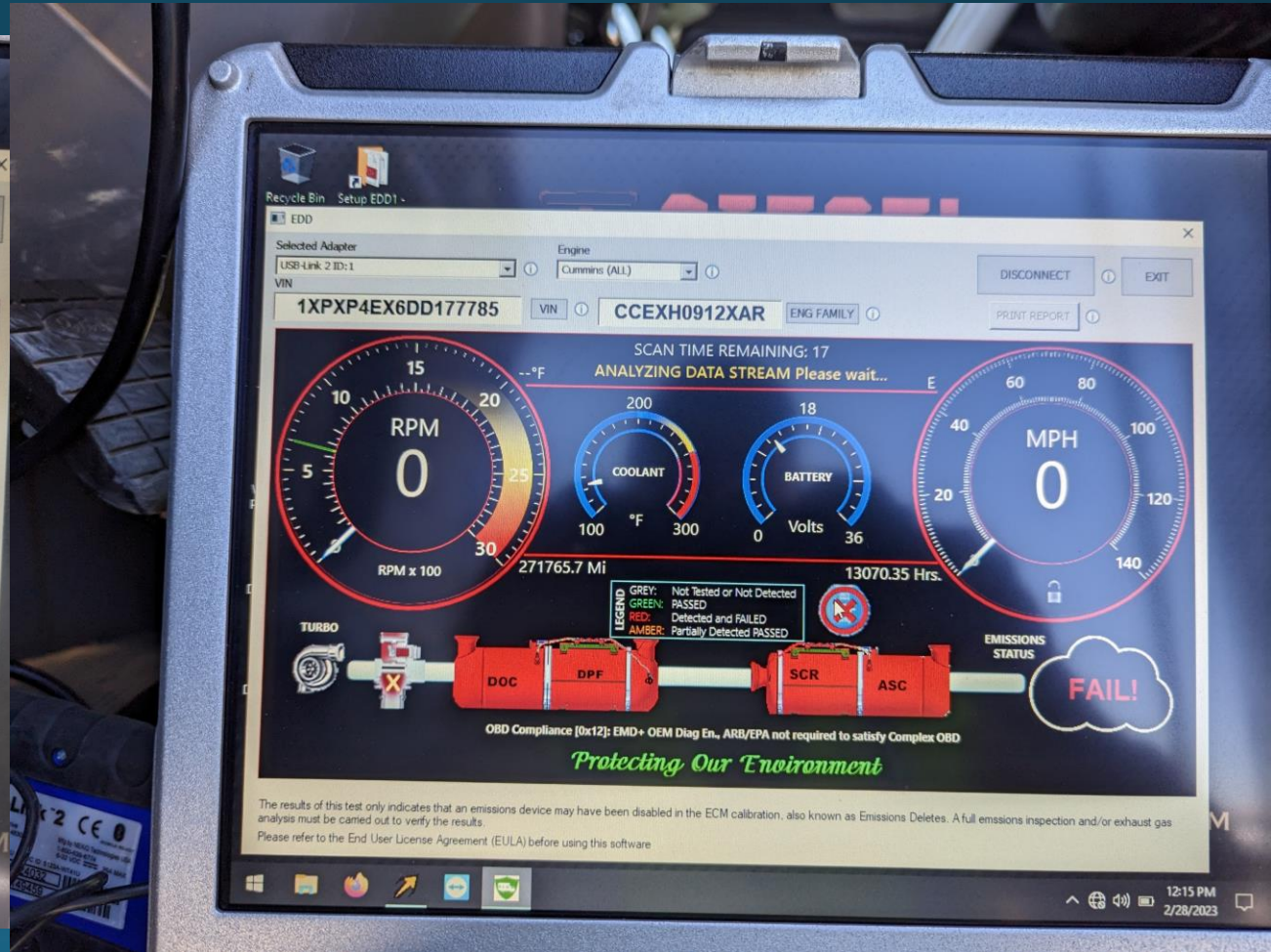
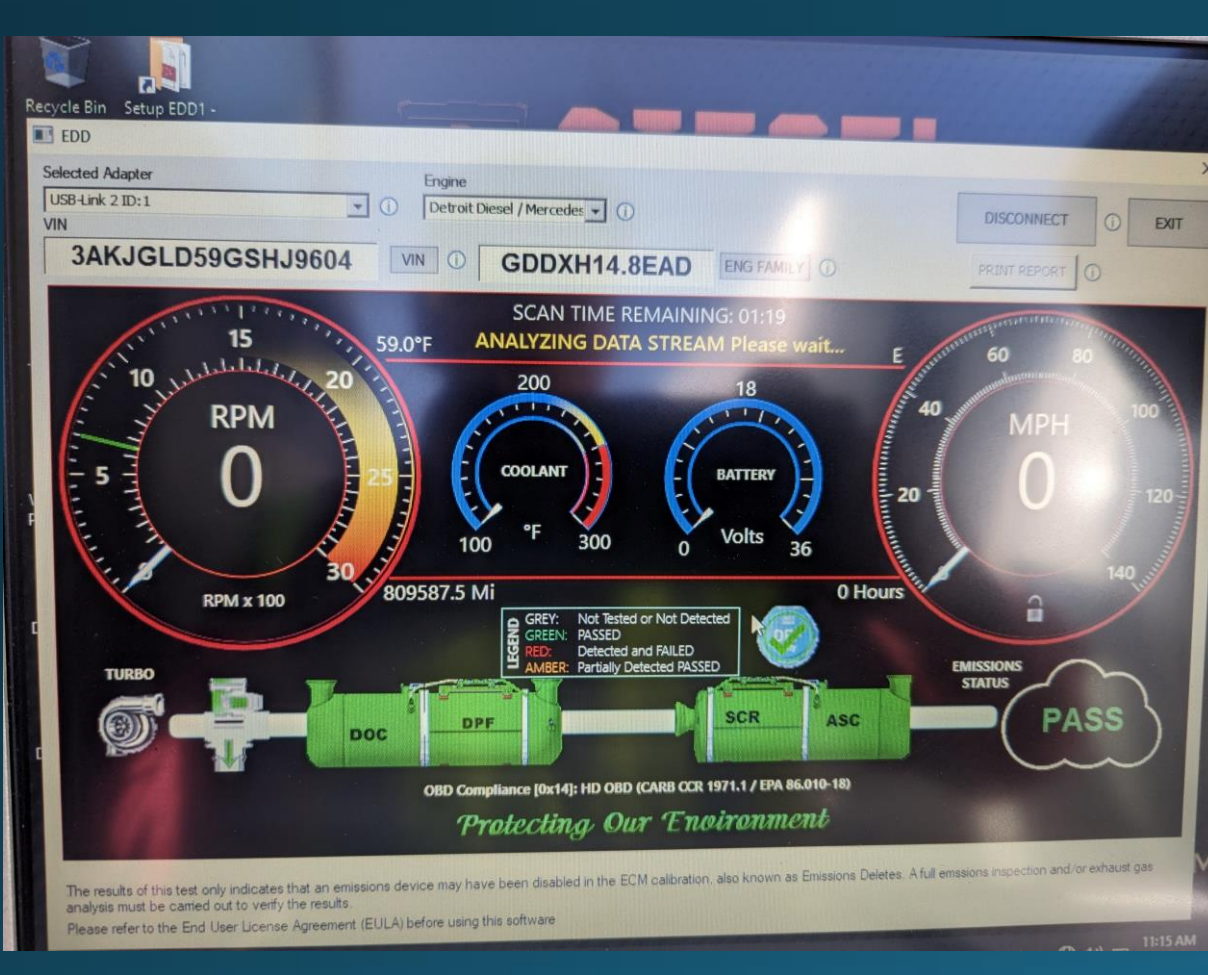
# Diesel Laptops Emissions Delete Detector (EDD)



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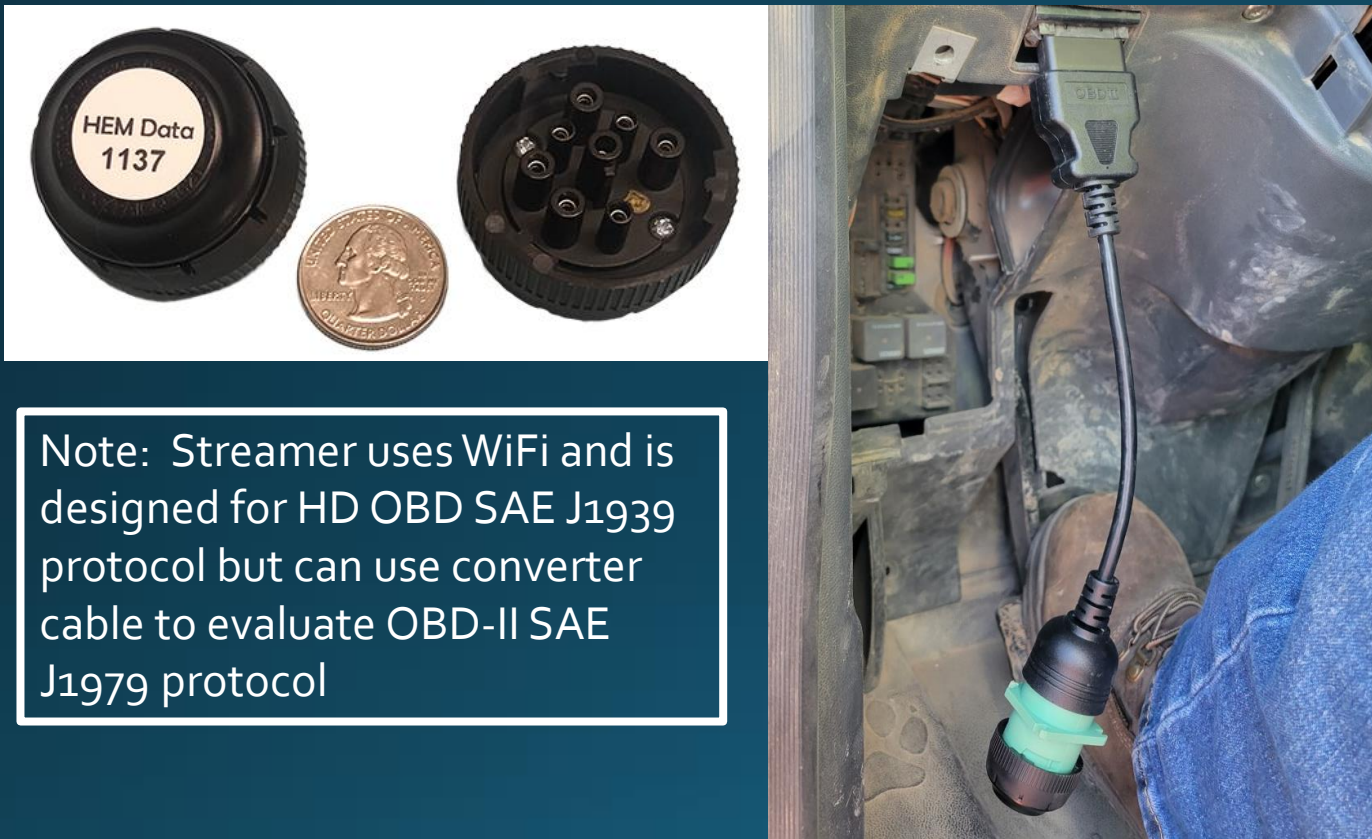
# Diesel Laptops Emissions Delete Detector (EDD)



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# HEM Data Mini Streamer with OBD Inspector Software



Note: Streamer uses WiFi and is designed for HD OBD SAE J1939 protocol but can use converter cable to evaluate OBD-II SAE J1979 protocol

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12:17 PM Tue Apr 26 100%

Restart Connected Stop

Engine Coolant Temperature	59.0000 f
Engine Oil Pressure	63.8000 psi
Engine Power	
Engine Rated Power	477.7520 HP
Engine Speed	599.6250 rpm
Engine Total Hours of Operation	13343.4502 h
High Resolution Total Vehicle Distance	531498.3125 mi
High Resolution Total Vehicle Distance #2	531498.3125 mi
Serial Number	DTD8C*472N13*80363097*
Soot Load Percent	49.0000 %
Total ECU Distance	
Total Vehicle Distance	531488.1250 mi
Total Vehicle Hours	
Vehicle Identification Number	3AXJGLD55GSHC0292

Progress: J1939  OBD-II

Parameters Uploads DME

Parameters table provides real-time feedback to the user.

# Reference Method

- EPA/ERG used the following two types of inspections to determine the tampered disposition for better scientific integrity:
  - Physical inspection – Physical examination of emission control hardware (EGR, DOC, DPF, SCR) and related components (sensors, other electrical connections).  
**Some examples:**
    - Straight pipes, EGR block plates
    - Unplugged sensors, valves
  - OBD data – Review of SAE-based parameters to identify evidence emission control hardware (EGR, DOC, DPF, SCR) and/or related components (sensors) were disabled and OBD system functions associated with these systems were disabled or otherwise bypassed collected with key on/engine running. **Some examples:**
    - OBD monitor characteristics
    - SCR/DEF diagnostics and operational characteristics
    - EGR diagnostics and operational characteristics
    - DPF diagnostics and operational characteristics



# Field Testing: Data Gathering



Physical Vehicle Inspections for this Study



# Field Testing: Data Gathering



# Tampering Disposition Determinations

- **Tampered**
  - **Apparent Tampering** = vehicle had visible physical evidence of being tampered.
  - **Discreet** = clear tampering (i.e., there is no other reasonable explanation for the observed anomalies besides tampering).
  - **Discreet with Subtle Evidence** = vehicle was tampered but not able to fully see the observable anomalies.
- **Indeterminate** = we observed one or more anomalous results that may be indicative of tampering but cannot confirm tampering beyond a reasonable doubt (e.g., we do not have sufficient information from the data and/or OEM).
- **Not Tampered** = no apparent evidence of tampering. This result, however, is not absolute. For example, our physical and data evaluation method may miss some less common and deeply-concealed emulators or discreet tampering on older trucks where minimal SAE-based parameters are available.



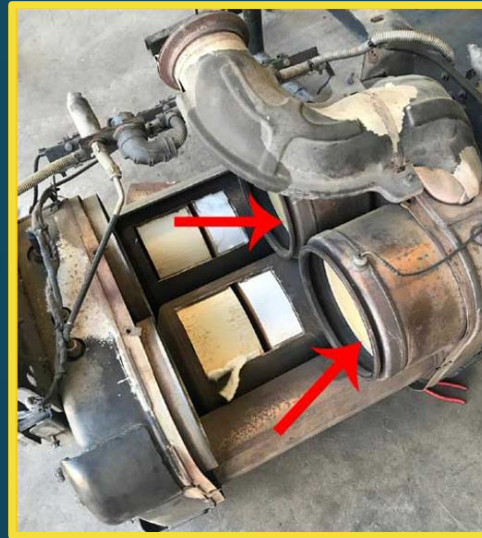
# Delete Examples

Process:

1. Aftertreatment is removed
2. Catalysts are gutted/punched out or drilled out
3. System is reinstalled

Source:  
<https://truckecmtunes.com/blog.html>

DOC

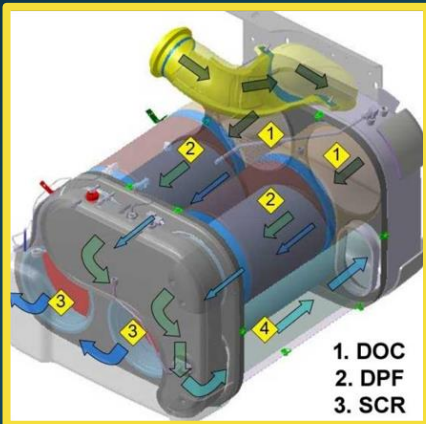


Red arrows point to DOCs with catalyst intact

DPF



Red arrows point to hollowed out DPF canisters



Stock aftertreatment system layout

SCR



SCR canisters cut open



SCR canisters removed



SCR canisters welded shut



EGR appears intact



Aftertreatment appears intact



Veh 27 – **Discrete Delete** (only detected through OBD Data)

EGR appears intact



Harnesses near aftertreatment unplugged



Veh 66 – **Discrete Delete** (Subtle Evidence, Confirmed by OBD data review)

EGR missing



Aftertreatment missing



Veh 24 – **Obvious Delete**

EGR missing



Veh 73 – **Obvious Delete**

# Study Findings using Reference Method

## Trucks with Engines using SAE J1939

	Total	Cummins	Detroit Diesel	PACCAR	Other
Not Tampered Trucks	37	16	16	5	0
Tampered Trucks	16	5	8	1	2
Indeterminate	4	1	2	0	1
Total	57	22	26	6	3
Breakdown of Tampered Trucks					
Discreet	9	2	5	0	2
Discreet with Subtle Evidence	3	2	1	0	0
Apparent Tampering	4	1	2	1	0



# Study Findings using Reference Method

## Trucks with Engines using SAE J1979

	Total	Cummins	Ford	Duramax	Volvo	Other
Not Tampered Trucks	12	0	3	1	7	1
Tampered Trucks	6	1	3	1	0	1
Indeterminate	1	1	0	0	0	0
Total	19	2	6	2	7	2
Breakdown of Tampered Trucks						
Discreet	0	0	0	0	0	0
Discreet with Subtle Evidence	0	0	0	0	0	0
Apparent Tampering	6	1	3	1	0	1

# Study Findings

- Both tools evaluated in this program were found to effectively identify tampering in their respective target fleets, with minimal false identifications with an 94% success rate to determine a tampered vehicle.
- A similar fraction of trucks were found to be tampered across trucks using either of the OBD SAE protocols
  - **16 of the 53 (30%) trucks using SAE J1939** for which a tampering disposition (other than indeterminate) was assigned were classified as “tampered”
  - **6 of the 18 (33%) trucks using SAE J1979** for which a tampering disposition (other than indeterminate) was assigned were classified as “tampered”
  - However, as noted in the beginning, these fractions are not representative of the fleet since efforts were made to select vehicles with potential tampering
- The **majority of SAE J1939 (typically HD) trucks that were tampered were discreet tampers**, while the trucks with **SAE J1979 (typically MD) that were tampered were visually identifiable**.

# Next Steps

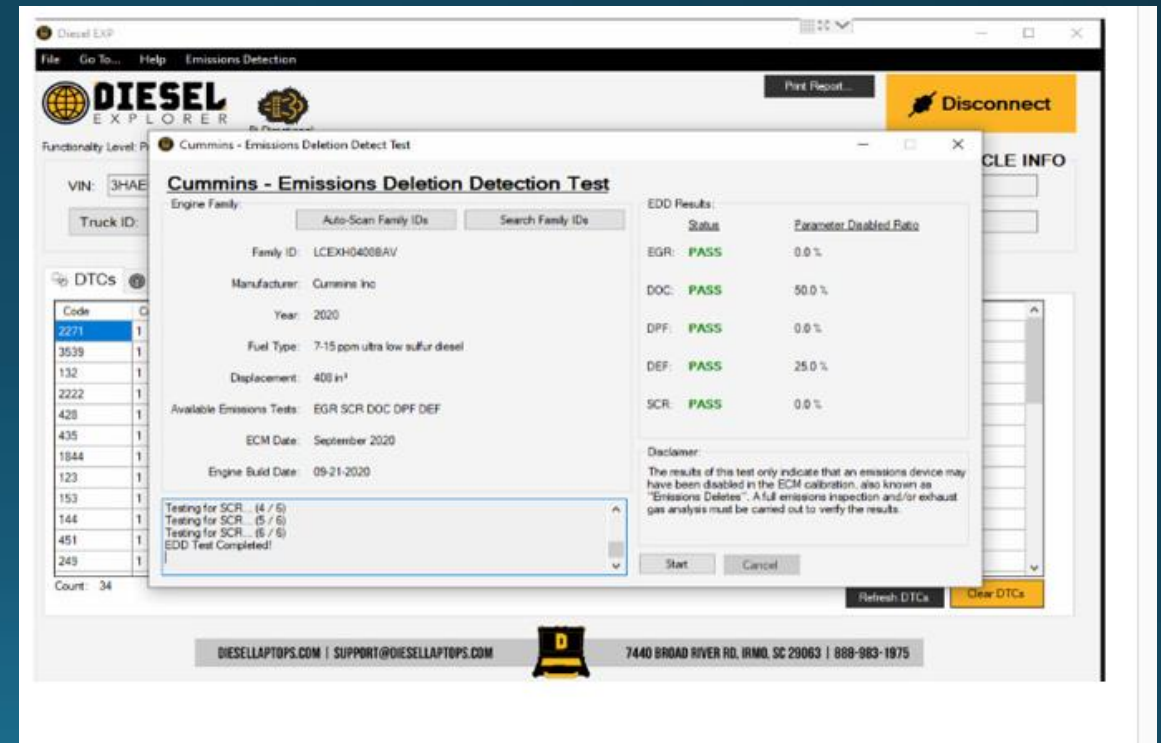
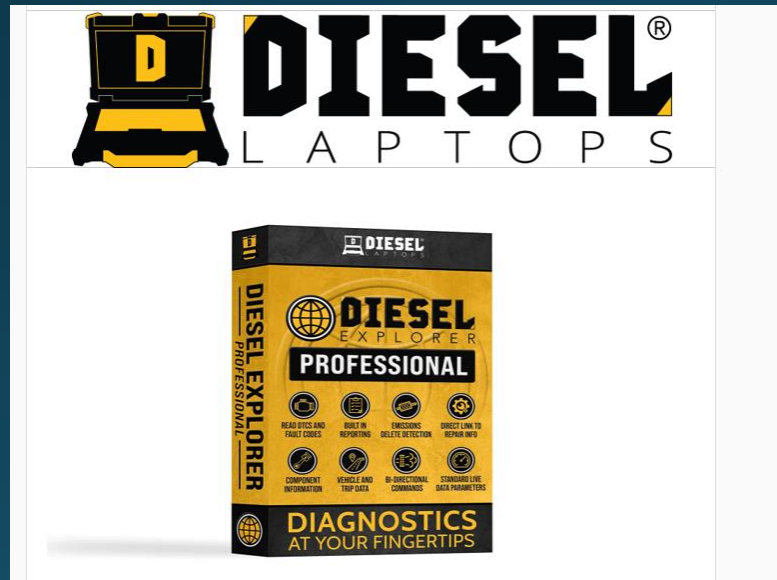
- EPA needs more data to determine the fraction of high emitting vehicles within the national fleet and is looking for partners to help gather this across the USA.
  - EPA has developed protocols, and methodologies plus equipment loans to help partners gather this data.



# Availability of Products

Disclaimer: EPA does not endorse any of these products and is only making the public aware of their existence for possible use.

- Diesel Laptops Emissions Delete Detector (EDD)
  - Announced in September 2023 that their product available.



# Availability of Products

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## HEM Data's OBD Inspector™ with TamperDetect™

Announced at the IM Solutions Conference in May 2023

The screenshot shows the HEM Data website with a navigation menu and a grid of products. The 'DAWN OBD Inspector' product is highlighted with a red border. The website header includes the HEM Data logo, a search bar, and navigation links for Home, About, Products, Support, and Contact. The main content area is titled 'Data Acquisition and Analysis Solutions' and features a grid of product cards. Each card includes an image of the product, the product name, and a brief description. The 'DAWN OBD Inspector' card is highlighted with a red border. The footer contains copyright information and contact details.

**HEM Data**  
Data Acquisition & Analysis Solutions

Home About Products Support Contact

**Data Acquisition and Analysis Solutions**

- OBD Mini Logger™**  
Conveniently fits directly on the J1962 OBD connector to acquire OBD, CAN, and J1939 data.
- DAWN PC Software™**  
Software suite with features including configuration, display and analysis.
- DAWN™ Dashboard**  
A custom website that automatically processes, analyzes and displays data.
- J1939 Mini Logger™**  
Conveniently fits directly onto the J1939 heavy duty connector to acquire CAN, J1939 and J1708 data.
- DAWN OBD Inspector™**  
Inspection/Maintenance tool for heavy-duty vehicles includes TamperDetect™ to find deleted emissions.
- CAN Mini Streamer™**  
Real-time streaming of data to a PC, iOS, or Android device for service, performance and vehicle inspections.
- Mini ADAQ™**  
4 to 20 analog channels with signal conditioning to acquire temperature, voltage, current, digital, frequency, etc.
- Applications/Training**  
See how our expertise can help with your application. HEM Data has written two books published by SAE.
- Enhanced Parameters**  
Manufacturer EOBD databases extend the number of available parameters on a vehicle beyond the standard OBD-II parameters.

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