Preliminary Findings on Heavy-Duty Vehicle Tampering: Field Study on Reference and Pre-Commercial Tools



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# **Study Objective**

- Study was performed to evaluate commercial (or pre-commercial) tools to "automatically" detect vehicles with potentially high emissions in <u>less than 2-</u> <u>3 minutes</u>
- "Tampered" For purpose of this study, means vehicles where emission control hardware (primarily EGR, DOC, DPF, SCR) are electronically and/or physically disabled and OBD software functions related to these systems were disabled or otherwise bypassed.

# 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)

#### • <u>Reference Tools:</u>

- HEM Data DAWN Mini-Streamer ("live" 1-hz datastream)
- RA Consulting's SilverScan ("snapshot" of operational data and diagnostics)
- Diesel Laptops Diesel Decoder ("snapshot" of operational data and diagnostics)

# **Tools Evaluated**

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

- <u>Diesel Laptops Emissions Delete Detector (EDD) (PocketFleet)</u>
  - 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 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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EXIT

### 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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Restart	Connected	Sto
Engine Coolant Temperature		59.0000 \$
Engine Oil Pressure		63.8000 pci
Engine Power		
Engine Rated Power		477.7520 HI
Engine Speed		599.6250 rpc
Engine Total Hours of Operation		13343.4502 1
High Resolution fotal Vehicle Dista	ince	531498.3125 mi
High Resolution Total Vehicle Distance	#2	531498.3125 mi
Serial Number		DTDSC+472813+50363097
Soot Load Percent		49,0000
Total ECU Distance		
Total Vehicle Distance		531488.1250 m
Total Vehicle Hours		
Vehicle Identification Number		3AK.NGLD55GSHC0293
	OBD-II	
1939 · · · ·		

# Field Testing: Data Gathering





**Physical Vehicle Inspections for this Study** 

# Field Testing: Data Gathering





# **Reference Method**

- EPA/ERG used the following two types of inspections to determine the tampered disposition:
  - <u>Physical inspection</u> 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

## **Tampering Disposition Determinations**

- **<u>Apparent Tampering</u>** = vehicle had visible evidences of being tampered.
- **Discreet** = clear tampering, beyond a reasonable doubt (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 beyond a reasonable doubt. 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:

Source:

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

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 canisters cut open

SCR canisters removed

SCR canisters welded shut





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





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



Veh 24 – Obvious Delete



EGR missing

### **Study Findings using Reference Method** Trucks with Engines using SAE J1939

			Detroit		
	Total	Cummins	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	Ο	3	1	7	1
Tampered Trucks	6	1	3	1	Ο	1
Indeterminate	1	1	Ο	Ο	ο	Ο
Total	19	2	6	2	7	2
Breakdown of Tampered Trucks						
Discreet	ο	Ο	Ο	ο	ο	ο
Discreet with Subtle Evidence	ο	ο	ο	ο	ο	ο
Apparent Tampering	6	1	3	1	0	1

## Study Findings – HEM Data Streamer with TamperDetect<sup>TM</sup>

#### **HEM Data Result**

	<b>Not Tampered</b>	Tampered	Indeterminate	Total
<b>Not Tampered</b>	34	3	Ο	37
Tampered	Ο	15	Ο	15
Indeterminate	1	2	ο	3
Total	35	20	0	55

Reference Method

## Study Findings – Diesel Laptops Emissions Delete Detector

**Diesel Laptops Result** 

		Not Tampered	Tampered	Indeterminate	Total
eruo	<b>Not Tampered</b>	26	1	3	30
ice m esult	Tampered	Ο	11	2	13
R	Indeterminate	2	1	Ο	3
Ϋ́Υ	Total	28	13	5	46

# Study Findings

- Both tools evaluated in this program were found to effectively identify tampering in their respective target fleets, with minimal false identifications
- 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.

## **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.

### • <u>Diesel Laptops Emissions Delete Detector (EDD)</u>

• Announced in September 2023 that their product available.





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A.8.4		Engine Family			EDD	Results		-
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		Family ID	LCEXH0408BAV		EGR:	PASS	0.0%	
DTCs	0	Manufacturer	Cummine inc		DOC	PASS	50.0 %	
Code	G	Year	2020					-
2271	1				DPF	PASS	0.0 %	
3539	1	Fuel Type:	7-15 ppm uitra low sulfur diesel					
132	1	Deplacement	408 in <sup>3</sup>		DEF:	PASS	25.0 %	
2222	1				070	PACE	0.05	
428	1	Available Emissions Tests	EGR SCR DOC DPF DEF		SUR	17435	0.0%	
435	1	ECM Date	September 2020					
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153	1	Testing for SCB (4.45)		121	"Enise	sions Deletes". A	full emissions inspection and/or exhaust	
144	1	Testing for SCR (5 / 6)		<u></u>	Sar a.	sargana muliti de ca	and the to really the results.	
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## **Availability of Products**

### HEM Data's OBD Inspector<sup>TM</sup> with TamperDetect<sup>TM</sup>

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Announced at the IM Solutions Conference in May 2023



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