
TECHNICIAN
TRAINING
BY DORMAN PRODUCTS
DORMAN
Training Seminar Series
Presents
Introduction Diesel Emissions
Putting It All together
Diagnosis Part 3

1


DORMAN
Aftermarket Innovators

2

Your Instructor For This Webinar

Sulev "Swede" Oun

- **Owner, O&K Truck and Auto Repairs Ltd.**
- **ATTP Master Instructor, New York State**
- **Author, "Medium/Heavy Duty Truck Electricity and Electronics"**
- **Training provider for various Associations, industry and various NY State agencies**
- **Developed trainings that range from four hours to multiple days, specializing in brakes, electrical, regulations and many other subjects relating to our industry.**
- **Member of various organizations such as SAE, CVSA, TANY**

okswede1@aol.com

3

Emissions 101

Sulev "Swede" Oun
O&K Truck Repairs Ltd.
350 Grand Island Blvd.
Tonawanda NY 14150
716-874-5450
E-mail: okswede1@aol.com

4

What Will Be Covered

- Most common issues and failures.
- Regeneration.
- DEF issues.

NOTE: Part 1 and Part 2 should be used as a reference for systems a Components review.

5

Welcome To Our World

Can you guess what this picture will lead to?
You have two guesses.

6

If you said diesel into DEF, this time you would be wrong.
How about DEF into diesel. Go figure. How often do you see that.

7

Can OBD Regulations/Requirements Help Us?

- **The HD OBD rule has approximately 124 required component /system monitoring requirements. (These numbers are constantly changing. More are added).**
- **In addition, there is a Comprehensive Component Monitoring (CCM) section to capture each input and each output component.**
  - **Each input sensor has six monitoring requirement**
  - **Each output actuator has four monitoring requirements.**
- **A malfunction Indicator Lamp (MIL) is required to alert operator of a malfunction.**
- **A service interface provides a standard diagnostic tool connector to be used to access hundreds of parameters and many messages for service providers such as:**
  - **Live data**
  - **Drive cycle data**
  - **Historic data**

Tool recommendation: A good scan tool. Do research and network with others to see what will do the best job for you.

8

Using a scan tool (generically) for an “EGR” issue.

1. **Establish communication**
   - Follow your scan tool instructions to establish the connection.
2. **Retrieve Trouble Codes**
   - Access the proper menu on scan tool.
   - Some might have a menu specific for EGR.
3. **Interpret the Trouble Codes**
   - Built in information from scan tool, online database, even google.
   - Note, print, save the codes for further reference.
4. **Monitor Live Data**
   - Access live data menu on your scan tool.
   - Look for any EGR related parameters such as EGR flow rate, EGR valve position, exhaust gas temperature, and intake manifold pressure.
   - Monitor your picked parameters in real time with engine running to observe the values and behavior.

9

Using a scan tool (generically) for an “EGR” issue.

5. **Compare the parameters picked to specifications**
   - Access the specifications from your available sources to determine if the parameter values are correct or not.
   - Compare the live data to specified values/ranges.
   - Any parameter falling out of specified range would be a suspect, indicating a problem.

VERY IMPORTANT: Know how the system is supposed to work!!!!!!!!!!!!!!!
Don’t go down the rabbit hole.
Can one issue cause another issue?

6. **Clearing Codes**
   - This can be optional.
   - If clearing, will the “light” stay off? Will the light come on?
   - **Does it come on immediately or do you have to run/drive vehicle to meet certain conditions, before the light comes on again?**
   - Clearing codes will reset the vehicles readiness monitors.
   - **What about pending codes?**
   - What about the counts on codes?

10

DPF Regeneration Generically

- In a perfect world, normal operation aftertreatment DPF "regeneration" occurs while the vehicle is being driven (passive) or "active" if a small amount of fuel is introduced into exhaust during regen. Sometimes regeneration can be executed by the driver when the vehicle is parked and idling (stationary regeneration). By now it should be considered a routine operation.
- However, OBD diagnostic monitoring system will often alert the vehicle operator of a malfunction requiring emissions repair(s), that can be as simple as a forced regen that a technician can perform better with a bi-directional scan tool and sometimes the issue/malfunction can wind up being more involved than just a simple regen.
- How do we know a service is required? Usually, aftertreatment icons on instrument clusters will indicate some need/requirement such as:
  - Aftertreatment Regeneration Required
  - High Exhaust Temperature (HEST)
  - Aftertreatment DEF Tank Low-Level Indicator

11

DPF Regeneration Generically

- The aftertreatment DPF Regeneration Required icon will typically flash when the DPF is full, requiring regeneration.
- The High Exhaust System Temperature (HEST) illuminates when a parked regeneration required is initiated. It also can indicate high exhaust gas temperature during a passive regeneration. Note: If the HEST icon is illuminated, do not park or operate the vehicle near structures, flammable materials, vapors etc.
- The aftertreatment DEF tank low-level indicator icon basically illuminates when the fluid level is low. When the level becomes critically low, it will most likely start flashing.

Note: An MIL will indicate an on-board diagnostic fault(s).

- Lamp may remain active after repair until system confirms repair.

12

DPF Regeneration Generically

Question? Does a forced regeneration fix every issue?

Answer: Different issues need different solutions. For example:

- **Sensors can trigger fault codes. Regen doesn't fix those kind of issues.**
- **Cleaning or replacement might be required.**
- **It's even possible that a different component of the "aftertreatment system" could be the cause of the perceived fault.**

- **Regenerations are meant to be an essential function to maintain the vehicles emissions reduction capabilities.**
- **Sometimes regeneration is required to correct an issue.**
- **Sometimes a forced regeneration is used to get a vehicle out of "limp mode" long enough to get it to your shop.**

13

Reviews/Takeaways if the truck cannot/allow a "regeneration"?

- **Some of the reasons that may prevent a DPF regeneration:**
  - **Clogged DPF filter.**
  - **VGT turbo operation**
  - **EGR fault codes**
  - **And there maybe other reasons**

Note: A regen that cannot be started could lead to a "derate" and then to an engine shut down.

Reminder: Regeneration is a process to burn the soot accumulation inside the Diesel Particulate Filter (DPF)

14

Generic Regen Failure List:

Engine Fault Codes

- Codes related to temperature, pressures, boost, VGT and others related to emissions.

VGT Operation

- Failed VGT's causing DPF failures not building enough heat causing the regens to fail.

Clogged DPF Filter

- Will not get the adequate temperature to properly burn off the soot.

NOTE: Some of the symptoms of a clogged DPF are long and excessive regens, typically lasting longer than 60 minutes.

If you suspect that, you need to monitor pressures and temperatures during a forced regen to assure everything is working properly and everything is in range.

Failed DOC (Diesel Oxidation Catalyst) ***"Revisit Part 1" for typical locations.***

- Also known as "pre-DPF filter" used to also create heat necessary to start the DPF burn process. The DOC is the location for the inlet temperature sensor.

15

Generic Regen Failure List cont.

Faulty Temperature Sensors

- Any failed sensor(s) (multiple sensors) will stop the regen process.
- Critical input to the ECM to determine how the DPF system is operating.

Failed DPF Pressure Sensor

- A failed sensor will provide false readings and possible cause excessive regens if it tells the ECM or ACM (Aftertreatment Control Module) that the DPF is full when it's not (high pressures).

REMINDER: This sensor is used to measure soot levels before and after the DPF filter to determine the pressure drop within the filter.

16

Generic Regen Failure List cont.

EGR Fault Codes

- Any EGR codes will usually abort the regeneration process.
- The "EGR system" is part of the "Aftertreatment System".

Failed Aftertreatment Hydrocarbon Doser (Injector).

- A failed injector prevents the system to increase temperatures necessary for a proper regeneration.
- This injector is used to inject fuel into the exhaust stream to increase the temperature to start the DPF regeneration process.

NOTE: This injector system should probably be one of the first things to check for a regen failure.

17

Exhaust Gas Temperature Does Matter

Exhaust Gas Temperature Sensors (EGTS)

- **This sensor is used to measure exhaust gas temperature at different locations in the exhaust system.**
  - It is common to have three or more "exhaust gas temperature sensors" in an exhaust system.
- Their purpose is to send real-time information to the ECU to monitor exhaust gas temperature so the ECU can make adjustments ensuring proper engine and emissions system operation.
- **The EGTS's are used to protect various components from higher temperatures attained by turbocharged engines (both gasoline and diesel). For example:**
  - Excessive temperature reported to the ECU will require the ECU to adjust parameters such as boost pressure or fuel delivery as necessary to reduce or maintain operating temperatures.
- **EGTS's are also used to monitor "particulate filter" to determine the exact temperature for "regeneration".**

18

Exhaust Gas Temperature Sensors

Three most common types utilized are:

- Negative Temperature Coefficient (NTC)
- Positive Temperature Coefficient PTC)
- Digital Thermocouple (DTC)

"NTC" and "PTC" differ in how they measure temperature. Both provide analog information.

A DTC type of sensor converts the analog signal to digital providing:

- Faster response time.
- Greater reliability.
- Higher accuracy.

Many illuminated "check engine lights", unnecessary DPF regeneration, fuel efficiency complaints and issues can be traced to the "EGTS"

19

DPF Regeneration Generically

Trouble shooting DPF regeneration

- **If possible (scan tool dependent), try retrieving the following information:**
  - Codes logged and are they related.
  - History of frequently cleared fault codes.
  - Regen Frequency.
  - How many hours since last regen.
- **What is the repair history?**
- Has the DPF been cleaned or how many hours since last cleaning?
- **Is the engine using oil or coolant?**
- Has the EGR system been checked?
  - Plugged EGR ports.

Tip: Restricted air filters, plugged EGR ports, boost leaks will generate codes that can be related to regen issues. Knowing prior codes can help in finding root causes.

Start with the "Basics"

20

Clearing Fault Codes?

Things to know before clearing fault codes

- Conditions for setting the fault code.
- Conditions for running the diagnostics/monitors.
- Actions taken when fault code is activated.
- What conditions must be met for clearing fault codes.

Another important concept.

- Resets may not clear the MIL lamp.
- Resets might not eliminate the "de-rate".
- Conditions for clearing the fault code and de-rate might not have been met because the conditions for running the diagnostics (trips) have not been met.

How many times have we ran across clearing the fault code, only to find the MIL lamp still stays on and de-rate is still active.

21

Aftertreatment DPF Regen Analyzer Test

- Requires a Cummins INSITE electronic tool software/subscription.
- **Used when directed by a published troubleshooting.**
- This test takes approximately 30 to 60 minutes to complete.
- **This test is used to identify malfunctioning engine performance components.**
- Examples of some of the tests/diagnostics performed:
  - Engine testing (in chassis).
  - Crankcase blowby, measure.
  - Aftertreatment Diesel Particulate filter.
  - Regeneration test.
  - Snap acceleration test.
  - Aftertreatment Selective Catalytic Reduction (SCR) System test.
- **The test status will be shown in a status window.**
- There is also a test description window and test instruction window.

22

Aftertreatment DPF Regen Analyzer Test

Example of a failed test:
EGR differential pressure is above specification.
Perform the following checks:

- **Clean and inspect the EGR valve.**
- **Clean and inspect the EGR differential pressure sensor.**
- **Check the EGR differential pressure sensor reading with the key switch on and engine off.**
- **If the EGR differential pressure sensor is 0 ±2 kpa (0±0.3 psi), replace the sensor.**

What Can Temperature Readings Indicate?

Diesel Oxidation Cat (DOC)
Suspect failed DOC if outlet temperature is lower than DPF outlet temperature.

- **This means the DOC is not burning the soot load effectively and the DPF is doing more of the burn than it should.**

NOTE: There is an acceptable temperature variation of 120º F+/- due to soot loaded DPF's burning hotter than a clean or new DPF.
Also, high idle times on running light load can store unburnt fuel in the DPF, causing higher regeneration temperature than normal.

In summary:
DPF outlet temperature higher than DOC outlet should be a cause for diagnosing if the DPF outlet is hotter than the DOC outlet by more than 122º F (according to International).

GO BACK TO PART1 and PART2 for DOC and DPF overview.

DPF Surface Temperatures

Important info for taking temperature readings:

- **DPF units typically are equipped with heat insulation covering most areas of the DPF.**
- **Uninsulated areas tend to be by the body connections, clamp areas, inlet and outlet pipes.**
- **Temperature readings are very much dependent on the degree of encapsulation and airflow around the DPF unit.**

25

Below approximates DPF surface temperatures.

Compact Style DPF

Position	Thickness of Insulation	Heat Active Regeneration
Inlet Section Side	6.35 mm (0.25 in)	290ºC (554ºF)
DOC Section	6.35 mm (0.25 in)	280ºC (536ºF)
DPF Section	6.35 mm (0.25 in)	280ºC (536ºF)
Outlet Section Side	6.35 mm (0.25 in)	290ºC (554ºF)
Outlet Section Bottom	25.4 mm (1.00 in)	300ºC (572ºF)
Clamping Area Side	No Insulation	350ºC (662ºF)

NOTE: These temperatures will also vary dependent on the style/type of system, vertical back of cab or in-line/series as an example.

26

Integrated Aftertreatment Hydrocarbon Dosing System

Hydrocarbon Injector Driver Module

- This one shown is used by Volvo and Mack 2017-12
- Integrated Dosing system.
- Typically located between fuel filter assy. And fuel pump.
- Typically used to inject extra fuel into exhaust to bring temperature up for active regeneration.

NOTE: Active regeneration occurs when temperatures during normal engine operation are insufficient to ignite the soot particles collected in the DOC and DPF.

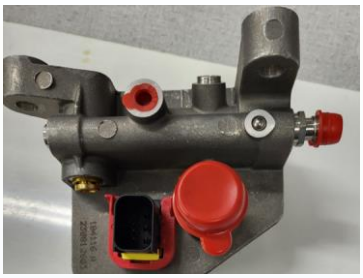
- A reaction between the fuel and precious metals in the DOC increases the temperature of the exhaust, causing the soot particles in the DOC and DPF to oxidize.

27

Integrated Aftertreatment Hydrocarbon Dosing System

It's a relationship.

- **This system is made up of three primary components:**
  - Aftertreatment Hydrocarbon Injector (AHI) module.
  - Fuel and air lines.
  - AHI injector/nozzle (sometimes called the 7th injector).
- **There are three primary failures with the module:**
  - Contaminated Air Supply (Air dryer, draining tanks?)
  - Contaminated Fuel Supply (Fuel filters, PM?)
  - Electrical Circuit Faults
- **Could this system affect the engine such as:**
  - Engine misfire?
  - Engine difficult to start ?
  - Erratic fuel pressure ?
- **Lines, fittings and kinked lines.**



28

Integrated Aftertreatment Hydrocarbon Dosing System

- **This system is quite often the cause for failed regeneration or constant request for regeneration.**
- **What is a requirement for proper regeneration?**
- **HEAT**
- **If the nozzle is clogged/plugged**
  - **It will not inject enough/sufficient fuel into the exhaust.**
  - **It might not properly atomize the fuel to distribute it evenly through out the DOC.**

29

What is a DERATE? (Quick Review)

- **A derate is designed to protect the engine and/or Aftertreatment System from damage.**
  - **The program inside the ECM limits either the power or vehicle speed.**
  - **The derate can be caused by various sensors.**
  - **Usually, the problem is related to emissions (aftertreatment system).**

NOTE: The number one cause of a derate seems to be the SCR/DEF system not operating properly.

- **The following are some of the components that control a "derate".**
  - **DEF Fluid – Quality, level (level/sensor) can put you in a derate.**
  - **DEF Pump Assembly- This unit pumps the DEF fluid throughout the system. Pump failure will put you into an immediate derate.**
  - **DEF Doser Valve- regulates DEF fluid injection into the SCR Catalyst. Failure will result in a derate.**
  - **Nox Sensors – Inlet and Outlet sensors used to detect quantity of Nox in the exhaust stream. Used to tell the SCR/DEF system when and how much urea to inject to reduce emissions levels. Failure of these sensors will cause a derate.**

30

SCR Issues and Diagnosing

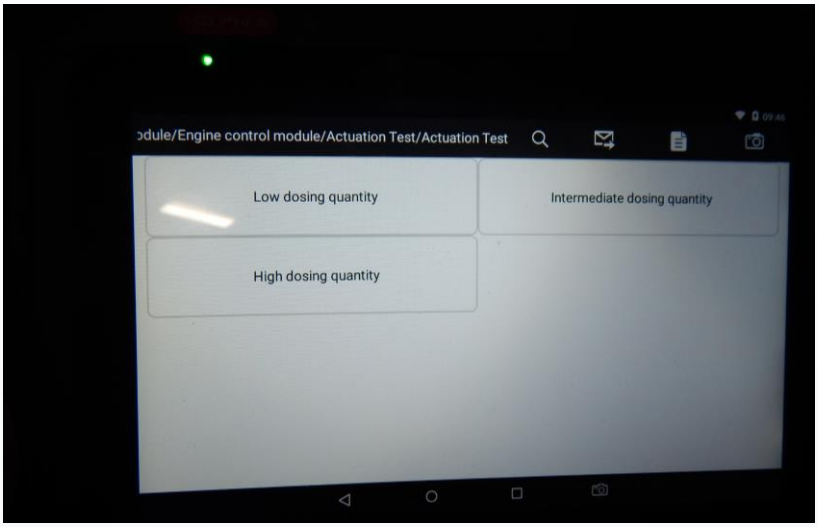
DEF

Suspecting DEF issues creating derate etc.

Question: Can your scan tool do a good enough of a job, verifying and perform bi-directional testing?

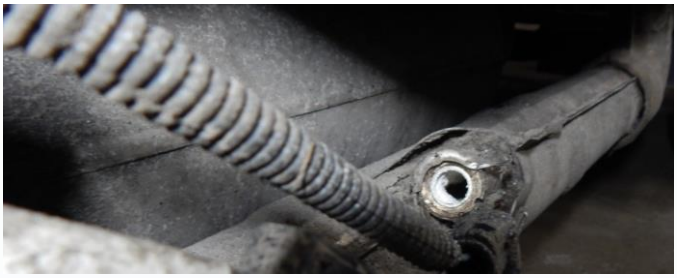
31

CanDo Scan tool actuation test.



32

33



34

35

36

37

38

39

40

41

42

43

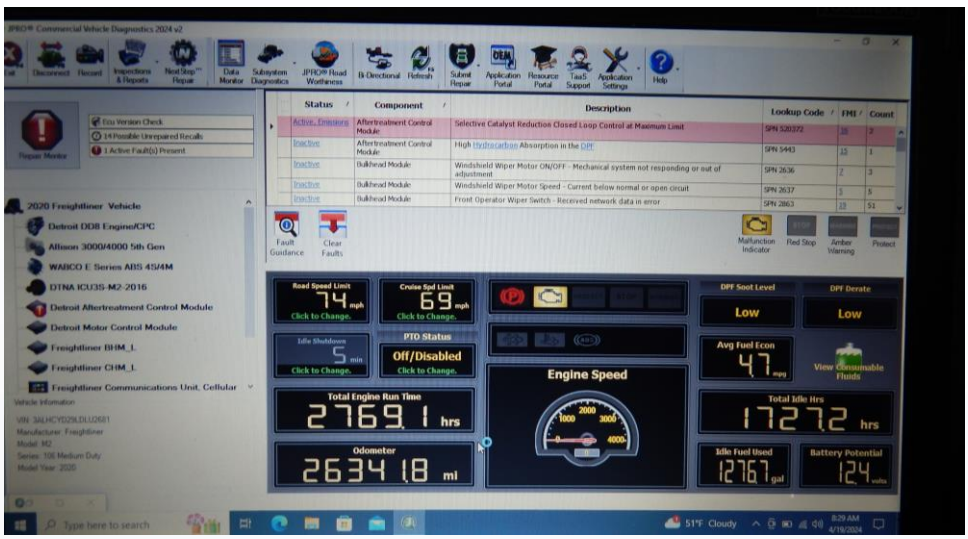
44

Another vehicles failed system.

45

46

47



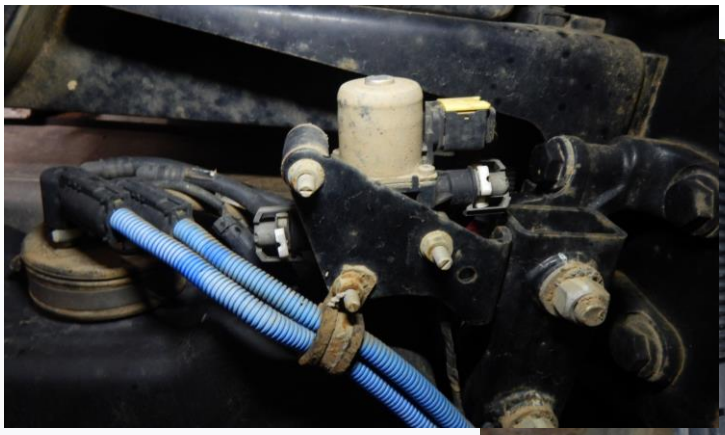
48

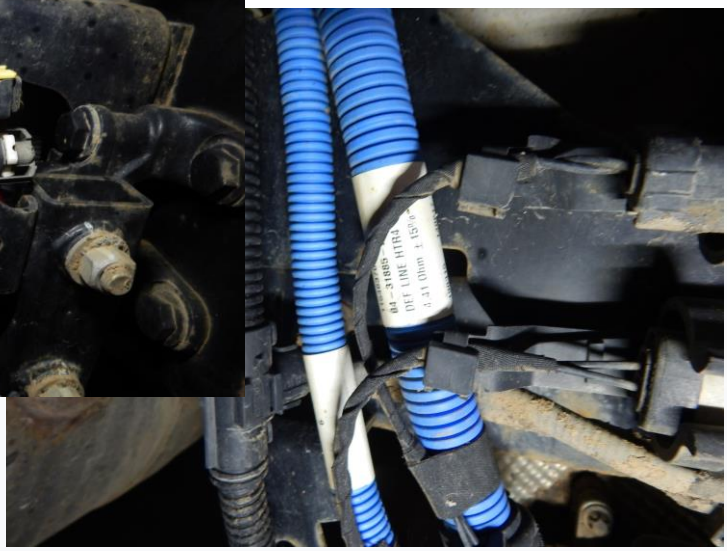
Getting Comfortable With Components

49

Good Sign.
Lots of room.
Of course everything will
Come apart easy.
“Hopefully”

50



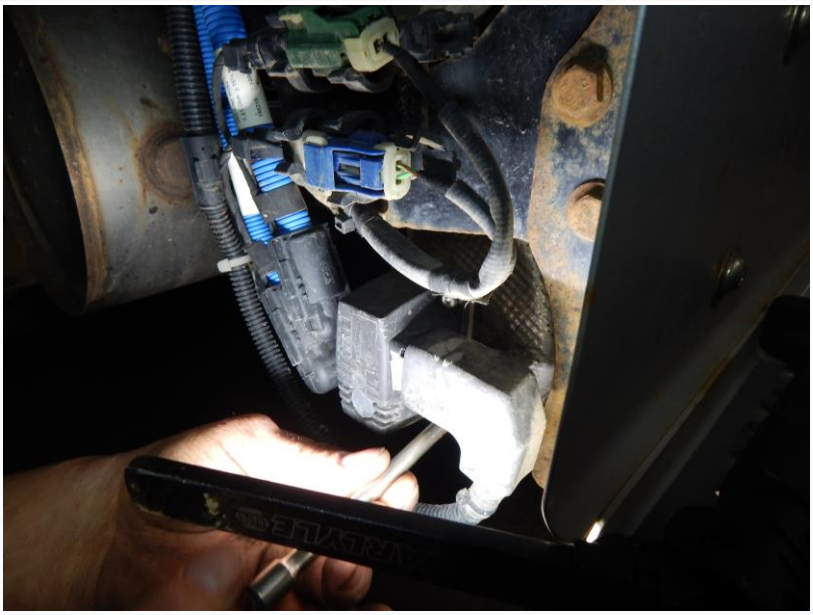


DEF lines going from tank to dosing unit. **Blue Lines (universal).**

51

Dosing Unit

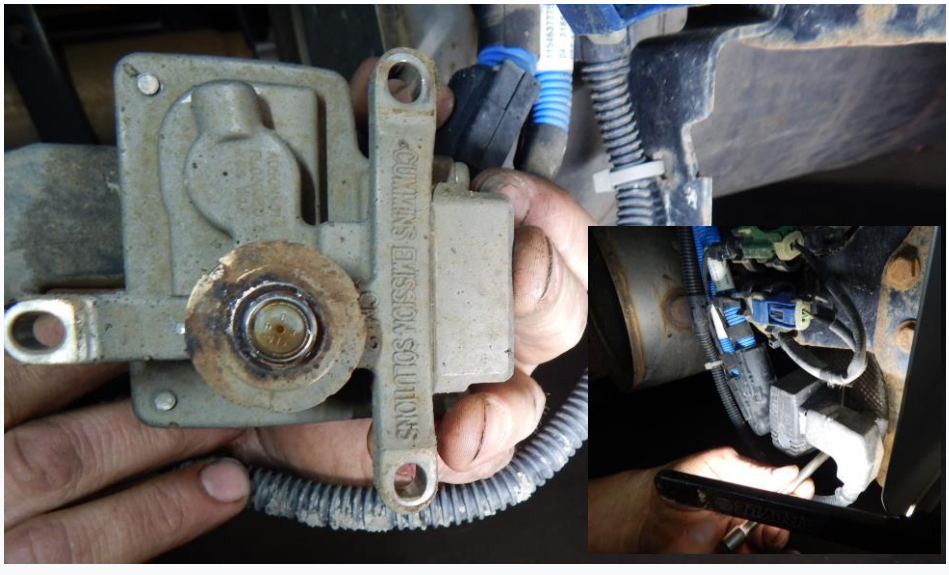
52



53

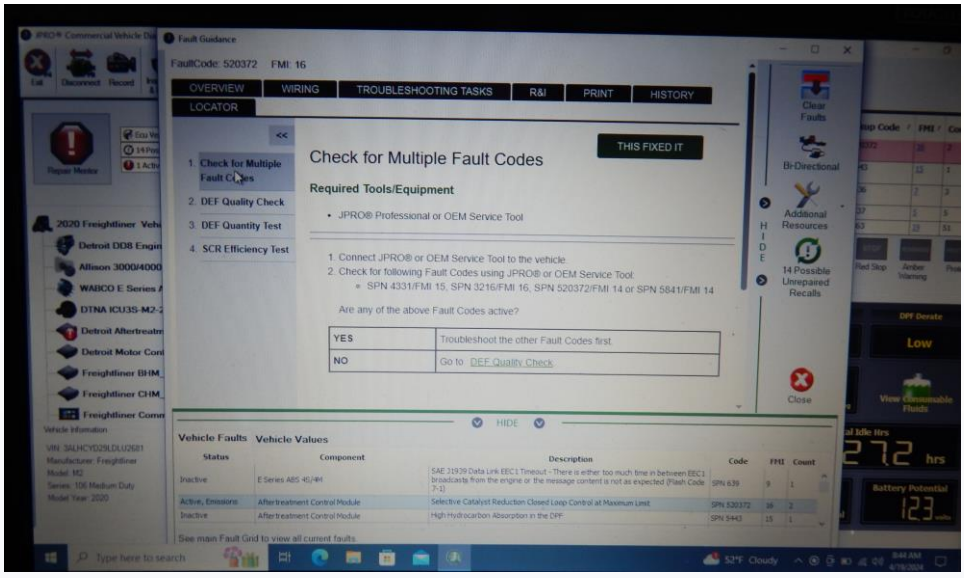
It came out.

Always a good feeling.

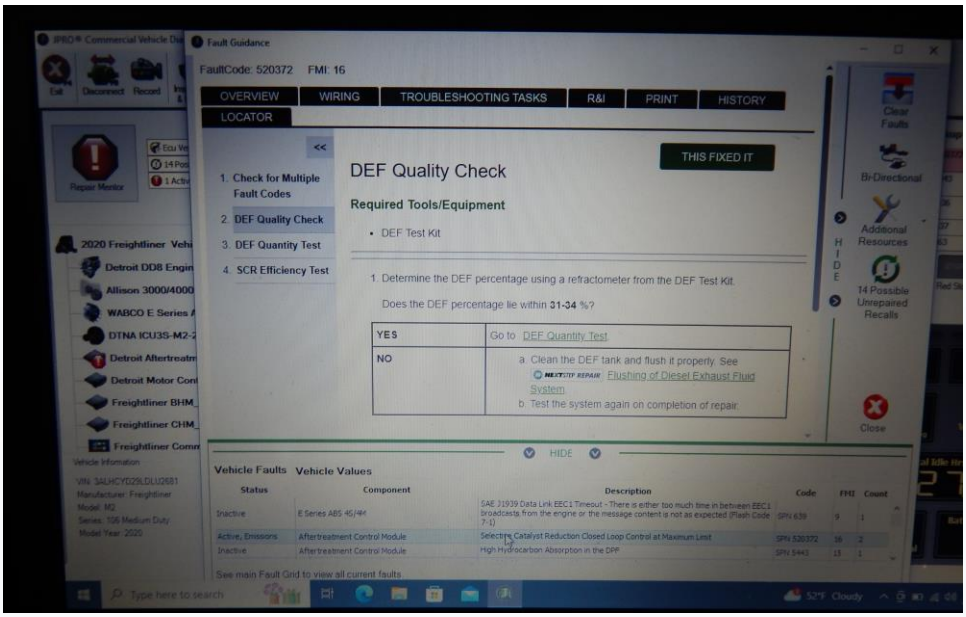


54

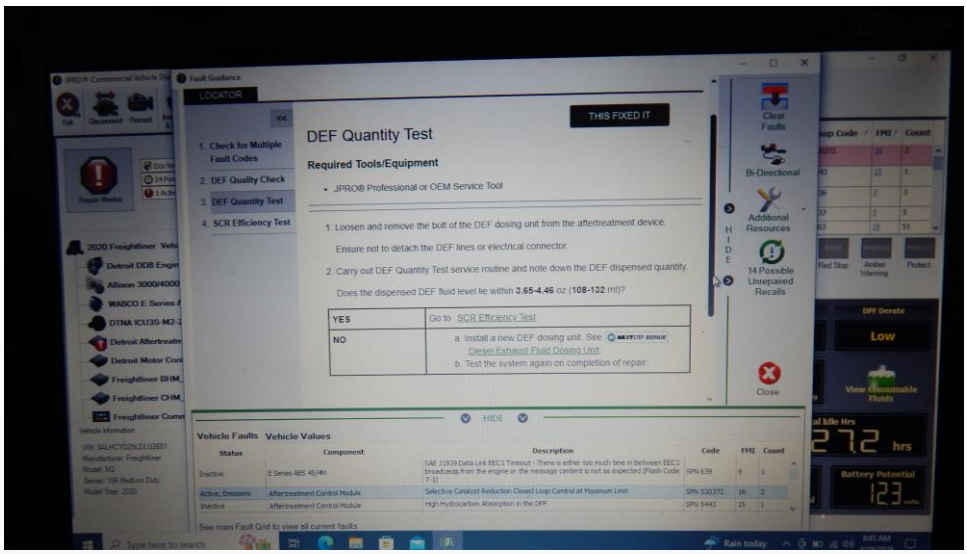
55



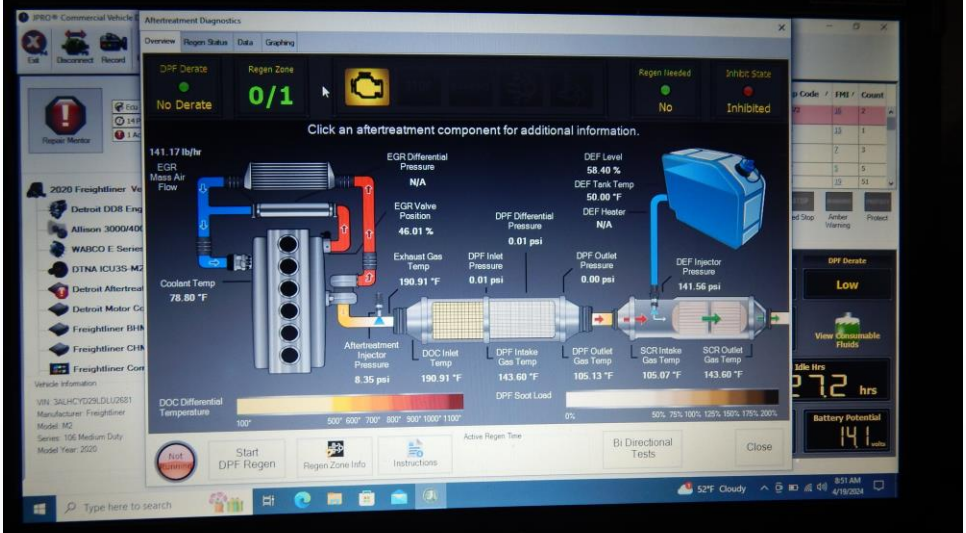
56



57

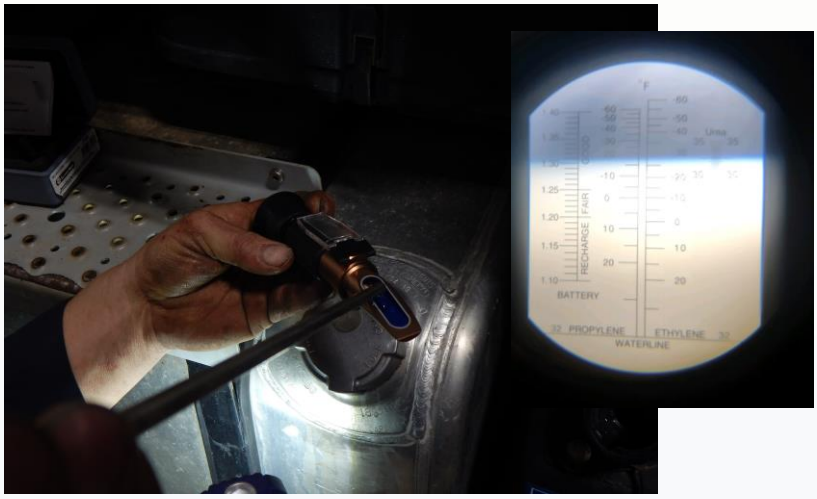


58



59

Test. Don't Guess

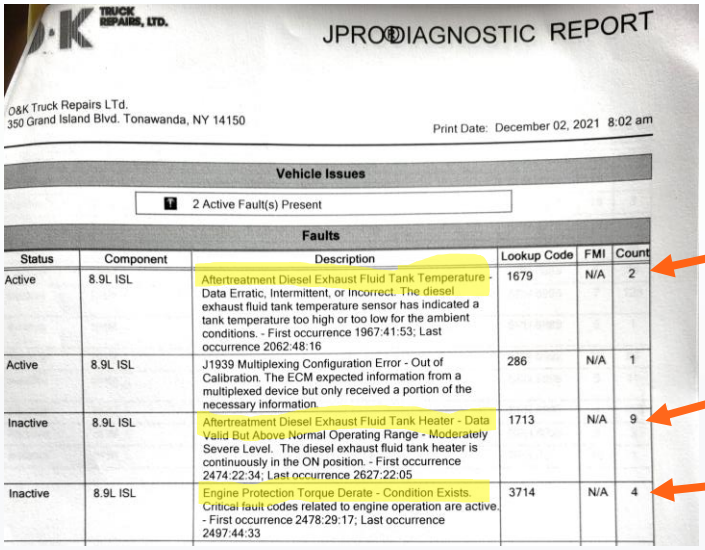


60

Another Issue.

Anything common with these? Is there a connection?

Where do we go from here?



O&K TRUCK REPAIRS, LTD.

JPRO® DIAGNOSTIC REPORT

O&K Truck Repairs LTd.
350 Grand Island Blvd. Tonawanda, NY 14150

Print Date: December 02, 2021 8:02 am

Vehicle Issues

2 Active Fault(s) Present

Faults

Status	Component	Description	Lookup Code	FMI	Count
Active	8.9L ISL	Aftertreatment Diesel Exhaust Fluid Tank Temperature - Data Erratic, Intermittent, or Incorrect. The diesel exhaust fluid tank temperature sensor has indicated a tank temperature too high or too low for the ambient conditions. - First occurrence 1967:41:53; Last occurrence 2062:48:16	1679	N/A	2
Active	8.9L ISL	J1939 Multiplexing Configuration Error - Out of Calibration. The ECM expected information from a multiplexed device but only received a portion of the necessary information.	286	N/A	1
Inactive	8.9L ISL	Aftertreatment Diesel Exhaust Fluid Tank Heater - Data Valid But Above Normal Operating Range - Moderately Severe Level. The diesel exhaust fluid tank heater is continuously in the ON position. - First occurrence 2474:22:34; Last occurrence 2627:22:05	1713	N/A	9
Inactive	8.9L ISL	Engine Protection Torque Derate - Condition Exists. Critical fault codes related to engine operation are active. - First occurrence 2478:29:17; Last occurrence 2497:44:33	3714	N/A	4

Fault Code: 1679
Lamp: Amber

- **This fault occurs when the DEF tank temperature sensor indicates a tank temperature that is too high or too low for the ambient conditions.**
  - **Chances are pretty good there will be a reduced engine performance.**

The following is critical information you need for this fault code:

Component location

- **For hardwired, the DEF tank temp sensor is in the DEF tank (OEM dependent).**
- **For Multiplexed, the DEF sensor is part of dosing unit in the DEF tank.**

Conditions for Running the Diagnostics. This is very "IMPORTANT".

- ***The engine must be turned OFF for a period of 8 hours before the diagnostic runs.***
- ***The diagnostics runs when the key is turned ON after an 8 hour "cold soak".***

Conditions for setting the Fault Code.

- **The ECM detects when the DEF tank temperature sensor reading is higher or lower than the other temperature sensors on the engine.**

Fault Code 1679 cont.

Action Taken When Fault is Active

- The ECM turns on the amber CHECK ENGINE light and the Malfunction Indicator Lamp (MIL) immediately when the diagnostic fails two consecutive trips (as per HD OBD requirements).

Conditions for Clearing Code

IMPORTANT:

- To validate repair, the engine shut off **(KEY-OFF) for 8 hours.**
- After the **8 hour cold-soak,** start the engine and let it idle for 1 minute.
- The fault code status (displayed on service tool) will change to inactive immediately after the diagnostic runs and passes
- The ECM turns off the amber CHECK ENGINE lamp after the diagnostic runs and passes.
- **For OBD engines, the ECM turns off the MIL after three consecutive trips where the diagnostics runs and passes.**
- Diagnostic service tools can command to "Reset All Faults" to clear active and inactive faults which turns OFF the MIL for OBD applications.

63

Highlights for checking DEF Temperature Sensor Accuracy

- Key ON and Engine OFF
- Connect a service tool (scan tool).
  1. Check the accuracy of the DEF tank temperature sensor by:
     - Measuring the temperature of the DEF in the tank with an infrared temp probe or thermocouple
  2. Compare that temperature to the parameter/monitor on your service tool.
     - Is the temperature between 5.6ºC (10ºF) of the measured value?
  3. If it is, the next step would be checking the DEF Temperature Sensor and Connector Pins.
  4. **If "NOT", replace the DEF tank temperature sensor.**

If you're lucky, that's as simple as it gets. If not, be prepared to :

- Check the circuit response by disconnecting the sensor (key 0ff), wait thirty seconds, turn key on and check for a response (an active code related to the sensor being disconnected).

The various steps will require you to check for opens, shorts and high resistances.

64

Cont.

Some examples:

Key-off and Engine-off

- Disconnect temp sensor from controller harness (service tool connected).

1. Key On and Engine Off
2. Place a jumper wire between DEF temp sensor SIGNAL Pin and RETURN Pin at the DEF tank temp sensor connector.
3. Wait 30 seconds and then check the circuit response.

If there is a response, replace the sensor.

If NOT, check ECM and OEM Harness Connector PINS.

If there is still an issue, the next step would be checking for an OPEN Circuit in the OEM Harness.

If there is still an issue, the next step would be checking for a PIN-to-Pin Short Circuit in the OEM Harness.

All of these require electrical fundamentals and meter usage knowledge.

65

66

We offer greater freedom to fix cars and trucks by engineering exclusive, labor-saving and cost-effective repair solutions.

Please use this QR Code to fill out a quick Survey

Thank You !

67