# Investigation Summary Report

# H&S Performance, SCT Performance, and Spartan Diesel Technologies

## July 2, 2014

Submitted to:

U.S. ENVIRONMENTAL PROTECTION AGENCY
Ariel Rios Building, 1200 Pennsylvania Ave., NW,
Washington, DC 20004

Submitted by:

Eastern Research Group, Inc.
14555 Avion Parkway, Suite 200
Chantilly, VA 20151

EPA Contract No. EP-W-12-007
EPA WA-1-1

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## EXECUTIVE SUMMARY

In December 2013, a compliance inspection team comprised of staff from EPA and EPA's contractor, Eastern Research Group, Inc. (ERG) conducted emissions tests of SCT Performance (SCT), Spartan Diesel Technologies (Spartan), and H&S Performance (H&S) products. This report summarizes the three devices sold by the aforementioned companies that changed the vehicle manufacturers' stock parameters within the engine computer module, as well as hardware designed to deactivate the exhaust gas recirculation system and exhaust aftertreatment device. Further, the manufacturers of these tuners could not have emission testing results that are in compliance with the regulations as demonstrated by EPA-purchased tuners on a Ford F-350 test vehicle with a 6.7 Liter Powerstroke turbo diesel engine. The test results confirm that the tuners and other devices alter the engine's operational design and profoundly increase regulated exhaust emissions of the vehicles on which they are installed.

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## I. INTRODUCTION

A compliance inspection team comprising staff from EPA and EPA's contractor, ERG, investigated SCT, Spartan, and H&S for manufacturing and selling potential defeat devices for on-highway engines. The investigation included purchasing engine computer module (ECM) tuning devices from each company, installing each tuner calibration on a test vehicle, and performing emissions testing. ERG and EPA traveled to Ford Motor Company (Ford) the week of 2 December 2013 to conduct emission testing on a test vehicle. The purpose of this testing was to identify which engine controls are altered by each tuner and how use of these tuners, along with defeat devices to physically bypass the exhaust aftertreatment systems, affect emissions of regulated pollutants.

| | |
|---|---|
| EPA Representatives: | Anne Wick, MSEB, EPA Headquarters<br>Anthony Miller, MSEB, EPA Headquarters |
| EPA Contractors: | Brent Ruminski, ERG<br>Michael Sabisch, ERG<br>Alan Stanard, ERG<br>Andrew Loll, ERG |
| Ford Representatives: | [redacted] |

Appendix A contains photographs taken during the investigation including at the Ford emissions test facility. Throughout the report, ERG refers to photographs in Appendix A as Photograph [#]. Section II provides additional background on the investigation.

## II. BACKGROUND

The companies investigated offer many types of automotive performance products, including the aforementioned engine computer module (ECM) tuners, cold air intakes, and tuning software for personal computers.[1] EPA focused this investigation on the ECM tuners. The companies investigated manufacture and sell these ECM tuners for use with on-highway light heavy-duty engines. They advertise these devices to increase performance and fuel economy. The companies and respective tuner models evaluated in this investigation are:

- Spartan Diesel Technologies (Spartan): 6.7 Liter Phalanx
- H&S Performance's (H&S): XRT Pro
- SCT Performance (SCT): 3015R

To date, the companies investigated have not submitted any documentation to EPA of completed emissions testing.

For this investigation, EPA was primarily concerned with investigating the following:

- *Emissions equipment-present calibrations*: Determining what engine parameters these types of calibrations alter and if these alterations adversely affect emissions.
- *Emissions equipment-removed calibrations*: Determining if each tuner is able to render inoperative or bypass emission control devices such as exhaust gas recirculation (EGR), selective catalytic reduction (SCR), oxidation catalyst (OC), diesel particulate filter (DPF) and devices involved in engine control. This includes determining what engine parameters these types of

[1] This software allows users to view, create, or modify calibrations.

calibrations alter and if these alterations adversely affect emissions. More specifically, this includes determining whether the tuners:

- Disable or alter functions of the ECM and OBD to allow the engine to operate after the user physically removes the emission control devices (applies to OC, SCR, and DPF); and/or
- Disable or alters functions of the ECM and OBD to defeat (i.e., electronically turn off) the EGR system without physically removing the EGR system.[2]

## III. PURCHASE OF TUNERS AND AFTERTREATMENT DELETE PIPE

ERG purchased the three tuners online as typical customer. Once received, ERG handled the tuners as evidence, completed chain-of-custody forms for each upon receipt, and properly maintained the documentation and evidence throughout the investigation. Table 1 summarizes some of the key functions of the three tuners that ERG confirmed during this investigation. The following subsections summarize how ERG purchased each tuner.

**Table 1. Summary of Tuner Capabilities**

| Parameter | Spartan Phalanx | XRT Pro | SCT 3015R |
|---|---|---|---|
| Number of vehicles tuner can be installed on | One, unless a second license is purchased | Unlimited as long as previous ECM was returned to stock | Up to five as long as previous ECM was returned to stock |
| Capable of defeating EGR when EGR system is not physically removed? | Yes | Yes (but must unplug two EGR sensors) | No |
| Capable of defeating EGR when EGR system is physically removed? | Yes | Yes | Yes |
| Capable of defeating aftertreatment system when physically removed? | Yes | Yes | Yes |

### A. Spartan 6.7 Liter Phalanx Tuner

On 13 September 2013, ERG purchased the Spartan Phalanx tuner through Rudy's Diesel Performance website.[3] The memorandum in Appendix C describes the purchasing process. Photograph [1] shows the Spartan tuner out of the box as received by ERG on 19 September 2013. Photographs [2] and [3] show the product description and the serial number as 018914130513Q.

The Spartan Phalanx tuner ERG purchased is only compatible with the Model Years 2011 and 2012 6.7 Liter Powerstroke engine. The 6.7 Liter Powerstroke is typically installed in Model Years 2011 and newer offered by Ford in their F-250 models and larger (e.g., F-350, F-450). A different version of the Phalanx was available that is compatible with the 6.4 Liter Powerstroke. The 6.4 Liter Powerstroke is typically installed on Model Years 2008 to 2010 Ford truck models F-250 and larger.[4]

[2] As determined by ERG during this investigation, this may or may not require the user to unplug wiring to the EGR valve depending on the tuner.
[3] More information on Rudy's Diesel Performance is available online at: www rudysdiesel.com.
[4] During the purchase process, there was some confusion on whether the tuner could be used on the 6.7 or 6.4 Liter Ford Powerstroke. The receipt ERG received indicated the tuner was for a 6.4 Liter. ERG called a sales representative at Spartan who indicated the desired tuner could be used on the 6.7 Liter. Upon receipt, ERG confirmed the tuner that was received could be used on the 6.7 Liter. The representative also indicated that the device could allow an EGR/DPF delete.

## B. H&S XRT Pro Tuner

On 18 July 2013, ERG purchased the H&S XRT Pro tuner from Monster Performance Exhaust.[5] Photograph [4] shows the XRT Pro tuner out of the box as received by ERG on 23 July 2013. Photograph [5] shows the serial number on the sticker as 0060039934 and also shows the date 21 March 2013 next to the serial number suggesting that H&S produced this unit on this date.[6] Photographs [6] and [7] show the warranty card ERG received with the XRT Pro which includes the part number and serial number. The warranty card also indicates that the XRT Pro is capable of installing software modifications necessary to support "off-road/race modifications".

The XRT Pro instruction manual indicated that the unit is compatible with the following engine model makes, models, and Model Years:

- 2006 – 2007: Cummins 5.9 Liter;
- 2007.5 – 2009: Cummins 6.7 Liter;
- 2010 – 2012: Cummins 6.7 Liter;
- 2003 – 2007: Ford Powerstroke 6.0 Liter;
- 2008 – 2010: Ford Powerstroke 6.4 Liter;
- 2011 – 2013: Ford Powerstroke 6.7 Liter;
- 2007.5 – 2010: Duramax 6.6 Liter; and
- 2011 – 2013: Duramax 6.6 Liter.

## C. SCT 3015R Tuner

On 16 September 2013, ERG purchased the SCT tuner from Rudy's Diesel Performance website.3 The memorandum in Appendix D describes the purchasing process. ERG received the SCT unit on 23 September 2013. Photographs [8] and [9] show the SCT tuner in its original packaging on the front side and back side, respectively. The serial number of the unit was XP06281339A62, as shown in Photograph [10].

During the purchasing process, Rudy's website indicated the SCT tuner was only compatible with the Ford Powerstroke 6.4 Liter. ERG emailed Rudy's Diesel Performance and asked if the tuner that was available was compatible with the Ford Powerstroke 6.7 Liter. A representative responded and stated that the tuner is in fact compatible with the 6.7 Liter. Both the website and the receipt indicated that ERG purchased the SCT 3025 tuner. However, the tuner ERG received was instead the 3015R model. The instruction manual that came with the tuner indicated it is only compatible with the engine model makes, models, and Model Years listed below. During testing, ERG confirmed the tuner is also compatible with Model Year 2011 Ford Powerstroke 6.7 Liter engine, which the manual did not list.

- 1996—2008 V-8 Mustangs, Cobras, Mach I and Shelby GT500;
- 1994—2008 V-6 Mustangs;
- 1997—2003 F-Series 4.6L / 5.4L / 7.3L Diesel ('99-'03 Only);
- 2004—2008 F-Series 4.2L / 4.6L / 5.4L / 6.8L / 6.0L Diesel;
- 2009 – 2010 F-Series 6.4 Liter Powerstroke;
- 1999—2004 Focus SVT / Zetec;
- 2003—2004 Mercury Marauder;
- 1999—2008 Crown Victoria;
- 2002—2006 Thunderbird 3.9L;

[5] Monster's website is available at: http://monsterperformanceexhaust.com.
[6] H&S reported to EPA they stopped selling EGR/DPF delete tuners on 11 July 2013 (based on internal communication from EPA to ERG on 1 August 2013).

- 2000—2006 Lincoln LS 3.9L;
- 1996—1999 Taurus SHO;
- 1999—2005 Excursion 6.8L / 6.0L Diesel;
- 1997—2006 Explorer 4.0L / 4.6L;
- 1997—2005 Expedition 4.6L / 5.4L; and
- 2005—2006 Ford GT Supercar.

### D. Flo-Pro Aftertreatment Delete Pipe

ERG originally ordered a Flo-Pro aftertreatment delete pipe with the Part Number 857 NB for the 6.7 Liter Powerstroke from USA Performance Exhaust[7] located in Butte, Montana. ERG purchased the system for the purpose of installing the system on the test vehicle and evaluating emission equipment-removed calibrations (SCR, DPF, OC removed). The aftertreatment delete pipe received the week of testing was Flo-Pro part number 837 NB, which is the 6.4 Liter Powerstroke model, instead of the 857 NB that ERG ordered for the 6.7 Liter Powerstroke. Photograph [11] shows the box received from USA Performance. Photograph [12] shows the document received with the aftertreatment delete pipe verifying that it is the incorrect part number 837 NB. ERG also confirmed it was the incorrect part by measuring the full length of the aftertreatment delete pipe. It was approximately one foot shorter than the stock bolt-on aftertreatment system.

ERG researched local performance shops in the Detroit area that Flo-Pro lists as certified dealers and identified Wolf Diesel Performance located at 396555 Willow Road, New Boston, Michigan. ERG called Wolf Diesel Performance on 3 December 2013 and ordered an 857NB aftertreatment delete pipe with overnight shipping. ERG returned the incorrect aftertreatment delete pipe to USA Performance and later received a full refund from the company.

On 4 December 2013, ERG received a call from a Wolf Diesel Performance[8] representative stating that the system arrived at their location. At that time, the representative requested that ERG pick up the system at Jimmy John's Gourmet Sandwiches located at 22211 West Road, Woodhaven, Michigan. When the contact met ERG and EPA in the parking lot, the facility contact was able to swipe a credit card for a payment of $255 to a PNC business account and immediately emailed a receipt to ERG. The Wolf Diesel Performance representative noted that he wanted to meet at Jimmy John's because his family owns the restaurant and he had to begin a work shift. He also stated that he typically ships parts to his customers for future reference. ERG and EPA arrived back at Ford in the afternoon of 4 December 2013 with the Flo-Pro 857 NB aftertreatment delete pipe.

Photograph [13] shows the box containing the Flo-Pro aftertreatment delete pipe as received by Wolf Diesel Performance. Photograph [14] shows the Flo-Pro aftertreatment delete pipe out of the box. This is a two piece system and contains no bungs.[9] The two main pipes have Part Numbers 31112NB and 31114NB. Photograph [15] shows that Wolf Diesel Performance's distributer is called Thunder Diesel located at 1835 Highway 201 South Spur, Mountain Home, Arkansas. It also shows that Wolf Diesel Performance had the distributer ship the unit to 18282 Huron River Drive, New Boston, Michigan instead of the address reported on Flo-Pro's website for Wolf Diesel Performance previously mentioned.

## IV. FORD TESTING OVERVIEW

Ford agreed to provide EPA with a test vehicle and conduct testing to measure emissions and engine operating data when various calibrations from the three tuners are installed. ERG and EPA traveled to

[7] USA Performance Exhaust's website is: http://www.usaperformanceexhaust.com/home.
[8] Wolf Diesel Performance does not have a website.
[9] The bungs in the OEM exhaust pipe are threaded holes for sensors.

Ford's testing facility in Allen Park, Michigan the week of 2 December 2013. Ford performed testing and ERG installed the calibrations. In addition, Ford allowed Bosch, their ECM supplier, to analyze what modifications the tuners make to the ECM data maps after the testing. The following subsections summarize the results and observations.

## A. Test Vehicle

Ford provided a Model Year 2011 F-350 with a 6.7 Liter diesel engine. Table 2 provides a detailed description of the test vehicle. Photographs [16] through [22] show the test vehicle at the time of the testing. The test vehicle was OBD II compliant and certified to meet model year 2011 emissions standards for complete[10] heavy-duty vehicles (40 CFR 86.1816-05 and 86.1816-08).

**Table 2. Ford Test Vehicle Description**

| Parameter | Value |
|---|---|
| Make | Ford |
| Model | F-350 |
| Model year | 2011 |
| Engine Configuration | V-8 |
| Engine Size (liters) | 6.7 |
| VIN | 1FT8W3CT6BEA00289 |
| Engine mileage (Odometer beginning of testing) | 33,933 miles[a] |
| Aftertreatment mileage | ~4,000 miles |
| EPA engine family | BFMXD06.771C |
| Emissions Equipment | EGR, SCR, OC, period trap oxidizer (PTOX)[b], turbo charger (TC), direct diesel injection (DDI), charge air cooler (CAC) |

a – This is the odometer reading observed at the beginning of testing on 2 December 2013.
b—This system contains the DPF.

Table 3 shows the emissions standard, certification level, additive deterioration factors (DF), and engine adjustment factor (EAF) for the test vehicle's engine family (EF), BFMXD06.771C. The table shows the standards for nitrous oxides ($NO_x$), particulate matter (PM), carbon monoxide (CO), and non-methane hydrocarbon (NMHC).

- DF is a factor that represents the increase in emissions over the life of a vehicle. Specifically, this is the increase between certification testing, when the aftertreatment has only been used for approximately 4,000 miles, and the end of the useful life of the aftertreatment system. The applicable emission standards define the useful life for EF BFMXD06.771C as 11 years or 120,000 miles. Engine manufactures must add the DF to the measured emissions when determining the official certification level.
- EAF is an additional factor added to the measured emissions for certification under certain circumstances. This factor accounts for excess emissions during DPF regeneration. Engine manufacturers must add the EAF to the measured emissions for certification if regeneration does not occur during the testing.[11]

[10] A complete vehicle is one that requires no further manufacturing operations to perform its intended function and is a functioning vehicle that has the primary load carrying device or container (or equivalent equipment) attached or that is designed to pull a trailer (40 CFR 523.2).
[11] More information on engine adjustment factors is available online at: http://www.epa.gov/otaq/highway-diesel/workshop/420f04022.pdf.

- Certification level is the measured emissions after all DFs and EAFs are added to the measured emissions for certifications. The certification level must be less than the certified standard.
- Certified standard is the applicable standard under 40 CFR Part 86 that the certification level must meet.

**Table 3. Certification Emission Levels and Standards for Engine Family BFMXD06.771C**

| Constituent | Additive DF (g/mi) | EAF (g/mi) | Certification Level (g/mi)[a] | Certified Standard (g/mi)[b] |
|---|---|---|---|---|
| NOx | 0.0000 | 0.0200 | 0.3000 | 0.4 |
| PM | 0.0070 | 0.0000 | 0.0100 | 0.02 |
| CO | 0.2300 | 0.0100 | 0.6000 | 8.1 |
| NMHC | 0.0334 | 0.0001 | 0.0510 | 0.23 |

a – Certified emissions levels for this engine family at the end of the useful life after applying appropriate DF and EAFs to the raw emission test results using an FTP75 test cycle.
b – Emissions standards this engine family is required to meet at the end of the useful life after applying appropriate DF and EAFs to the raw emission test results using an FTP75 test cycle.
Source: All data is available on EPA's website at: http://www.epa.gov/otaq/crttst.htm.

## B. Testing Procedures

The following subsections describe the test procedures Ford, EPA, and ERG followed the week of testing including:

- Tuner calibration installation;
- Aftertreatment delete pipe installation;
- Obtaining OBD data;
- Obtaining live engine data; and
- Test cycle selection and test descriptions.

After consulting with Ford, EPA decided to test each calibration/tuner with the F-350 using a consecutive series of FTP4-74 and US06 test cycles. These tests are described in more detail in Section IV.B.5. Table 4 summarizes the matrix of test cycles and calibrations EPA completed for each tuner at Ford's testing facility. Ford completed a baseline FTP4-74 test on the F-350 prior to the week of 2 December 2013 on 26 November 2013 prior to ERG's and EPA's arrival at the testing facility. In addition, Ford completed a baseline US06 test cycle after the week of 2 December 2013. Ford stated that DPF regeneration occurred on the test vehicle prior to the baseline test on 26 November 2013 such that regeneration would not occur during the actual emission tests. ERG and EPA confirmed that no regeneration occurred during any of the emission tests.

**Table 4. Chassis Dynamometer Test Matrix for Testing at Ford**

| Tuner | Test | Baseline | Emissions Equipment-present | Emissions Equipment-Removed |
|---|---|---|---|---|
| Spartan | FTP4-74 | 11/26/2013 | 12/2/2013 | 12/5/2013 |
| | US06 | 1/3/2014 | 12/4/2013 | --[a] |
| XRT | FTP4-74 | 11/26/2013 | 12/2/2013 | 12/6/2013 |
| | US06 | 1/3/2014 | --[a] | --[a] |
| SCT | FTP4-74 | 11/26/2013 | 12/3/2013 | 12/5/2013 |
| | US06 | 1/3/2014 | 12/3/2013 | --[a] |

a – Due to limited access to the test cell, these tests were not performed.

Table 18 in Appendix B provides a more detailed order of procedures than what is shown in Table 4 that Ford, EPA, and ERG completed during the testing at the Ford laboratory the week of 2 December 2013.The following describes how Ford, EPA, and ERG tested each calibration for each tuner.

1. ERG and EPA removed the original ECM in the truck and installed the original equipment manufacturer (OEM) stock-calibrated ECM assigned to the tuner being tested. Ford supplied a new stock ECM dedicated to each tuner being tested.
2. Ford reset the anti-theft system on the vehicle which is required when a new ECM is installed. Without this process, the engine would not run. This process involves connecting a Ford laptop to the ECM and running a program for approximately 10 minutes.
3. ERG obtained the calibration identifications (Cal ID), calibration verification numbers (CVNs), the status of the malfunction indicator light (MIL), and any diagnostic trouble codes (DTC) from the ECM with the existing calibration installed. See Section IV.B.3 for more information on what these parameters are and how ERG obtained them. ERG started the engine momentarily at the beginning of this step to allow the ECM to detect DTCs and to recalculate the CVN.
4. ERG installed one of the calibrations using the tuner. See Section IV.B.1 for detailed procedures ERG followed for each tuner and calibration installation.
5. ERG obtained the Cal ID, CVN, MIL status, and any DTCs from the ECM with the calibration installed. See Section IV.B.3 for more information on what these parameters are and how ERG obtained them. ERG started the engine momentarily at the beginning of this step to allow the ECM to detect DTCs and to recalculate the CVN.
6. Ford connected an ECM data logger to the vehicle to obtain live engine data parameters over time during the testing. See Section IV.B.4 for detailed procedures related to the ECM data logger.
7. Ford performed one of the two test cycles selected for testing. See Section IV.B.5 for more details on these test cycles and procedures.

Testing of emissions equipment-removed calibrations required installation of an aftertreatment delete pipe. The installation process for this delete pipe is described in Section IV.B.2.

### 1. Tuner Calibration Installation

Each purchased tuner came preloaded with multiple calibrations. For the purpose of this investigation, ERG categorized calibrations into one of two categories:

- Emissions equipment-present – These calibrations modify engine data maps to alter engine operating parameters (e.g., injection timing, fuel injection quantities). These calibrations do not disable emission control devices.
- Emissions equipment-removed – These calibrations defeat emission control devices in addition to the functions performed by emissions equipment-present calibrations.[12]

Ford provided three identical OEM ECMs for testing each with a stock calibration. ERG installed a new ECM onto the test vehicle for each tuner so that each tuner had a designated ECM which allowed Bosch to analyze calibrations from all three tuners after testing without the potential for interference from flashing the ECM using multiple tuners. Table 5 shows the ECM serial number designated to each tuner.

[12] This includes calibrations that disable functions of the OBD that would otherwise prevent the engine from running if a vehicle owner was to tamper with an emission control device. This also includes calibrations that electronically disable the function of entire emission control system without physically removing the system.

**Table 5. Designated ECM Serial Numbers for Each Tuner**

| Tuner Make and Model | ECM Serial Number |
|---|---|
| Spartan 6.7 Liter Phalanx | 260310-2593 |
| XRT Pro | 260210-0143 |
| SCT 3015R | 160210-1855 |

The following subsections provide a more detailed description of the tuners including the installation process ERG followed for emission equipment-present and equipment–removed calibration installation.

### a. Spartan 6.7 Liter Phalanx Tuner

After powering on the Spartan tuner, shown in Photograph [23], the user is immediately prompted to agree to the "off-road" disclaimer shown in Photograph [24]. The main menu has several icons including "load tune" and "load stock" which were the two menu options used to install preloaded calibrations to the ECM and return in to stock, respectively. As received, the Spartan tuner showed no preloaded tunes available for install. As directed in the installation manual, ERG completed the following steps to activate the Spartan 6.7 Liter Phalanx tuner:

1. Set up an account on Spartan's website and entered detailed information about the vehicle[13]
2. Sent an email to Spartan with a signed license agreement
3. Copied an index file received from Spartan via email after completing Steps 1 and 2 to the tuner's memory card

Appendix E provides emails and screenshots documenting each step described above. ERG placed the memory card back into the tuner. Once the memory card was inserted into the tuner containing the index file, the following preloaded tunes for the 6.7 Liter Powerstroke were available in the tuner's "load tune" menu:

- 25HP DPF On Cab & Chassis Only;
- 90 HP DPF On Cab & Chassis Only;
- 50 HP DPF On;
- 125HP DPF On;
- 40 HP DPF Off;
- 80 HP DPF Off;
- 120HP DPF Off;
- 165HP DPF Off; and
- 200HP DPF Off War Hammer Race.

For emissions equipment-present testing, ERG installed the "125 DPF On" calibration as shown in Photograph [26]. The tuner does not allow the user to input any other options after selecting the calibration to install.

For emissions equipment-removed testing, ERG selected the performance calibration as shown in Photograph [27]. The tuner does not allow the user to input any other options after selecting the calibration to install. Spartan's instructions for disabling the EGR and aftertreatment system were vague.

[13] The detailed information included tuner serial number, vehicle model year, vehicle model, transmission type (automatic), gear ratio, tire size, manufacturer date, engine strategy code, and transmission strategy code.

On 3 December 2013, ERG called Spartan technical support and asked if it was necessary to unplug sensors for the EGR and aftertreatment system. The Spartan representative instructed ERG to leave all electronic EGR sensors plugged in and stated that when a "DPF off" tune is selected, the calibration automatically turns off the EGR valve. The Spartan representative also stated that the sensors in the aftertreatment should be left plugged in and secured in another fashion assuming the aftertreatment delete kit (i.e., straight pipe) has no bungs.

### b. H&S XRT Pro Tuner

When powered on for the first time and connected to a vehicle, the H&S XRT Pro immediately prompts the user to enter the vehicle model and model year. On the first day of testing, ERG selected "11-12 Ford 6.7L Powerstroke" (see Photograph [28]).

To install a new calibration, ERG selected the "download" menu option. Within this menu, ERG used the "Download H&S tuning" and "Return to stock (OEM tune)" options to install new calibrations and return to stock, respectively (See Photograph [29]). After selecting to download a new calibration, the tuner prompted ERG to answer a series of prompts. Table 6 shows the H&S XRT Pro installation prompts in sequential order and indicates the options ERG selected for testing by calibration type. Photographs [30] through [34] show screenshots for each prompt during the Ford testing installation. Prompts 4 and 5 only become available after the user enters the "upgrade code" to unlock the "high sulfur" calibrations. For this tuner, "high sulfur" indicates that the user has removed the aftertreatment system and either removed or unplugged the EGR.[14] ERG entered the "upgrade code" provided on the warranty card, shown in Photograph [6], into the emissions selection menu (see Photograph [35]). Entering this code unlocked the emission equipment-removed calibrations as indicated in Photograph [36].

**Table 6. Installation Prompts for the H&S XRT Pro Tuner**

| Step # | Prompt | Input Options | Option Selected for Testing | | Photograph # |
|---|---|---|---|---|---|
| | | | Emission-Equipment-Present Calibration | Emission Equipment-Remove Calibration | |
| 1 | Please Select Power Level | • Stock<br>• Street<br>• Tow<br>• Performance | Performance | Performance | 30 |
| 2 | Do you want to adjust the speed limiter? | • Yes<br>• No | No | No | 31 |
| 3 | Do you want to tune the transmission? | • Yes<br>• No | No | No | 32 |
| 4 | Is the emissions system still PRESENT on this vehicle, or has it been REMOVED or modified for high sulfur fuel use? | • Present<br>• Removed | Present[a] | Removed | 33 |
| 5 | Do you want to adjust low boost fueling? | 1. Stock fueling (less smoke)[c]<br>5. No limit (more smoke)[c] | N/A[b] | 5 | 34 |

a—This prompt only appears after entering the "updated code" into the emissions selection menu.
b—This prompt does not appear for when the answer to prompt 4 is "present".
c—The user may enter any value form 1 and 5 but descriptions are only provided for 1 and 5 in the table above.

[14] The use of "high sulfur" by H&S is irrelevant to the type of fuel used.

The H&S XRT tuner requires the user to unplug several electrical connections to emission control systems for emissions equipment-removed calibrations. The instruction manual clearly indicates that two EGR harnesses must be unplugged in order for the emissions equipment-removed calibrations to work without physically removing the EGR system. Photographs [38] and [39] show these two harnesses. ERG and EPA, with the assistance of Ford, disabled the EGR by unplugging both two harnesses. The rest of the EGR system remained fully installed. The instruction manual also clearly indicated that the sensors on the aftertreatment system must be unplugged. Section IV.B.2 provides more information on these sensors.

### c. SCT 3015R Tuner

After the SCT tuner turns on, a simple menu option appears. To install a new calibration, ERG selected the "strategy tune" menu option (see Photograph [39]). When ERG attempted to install the first calibration onto the test vehicle on 2 December 2013, the SCT tuner recognized the 6.7 Liter Powerstroke engine as shown in Photograph [40]). However, the next screen stated "ECU unsupported, additional update needed, please run auto-update" (see Photograph [41]). ERG immediately hooked the SCT tuner to a laptop computer and ran the auto-update software that came with the tuner on a CD. After this update, the SCT no longer reported this error during the installation process.

Table 7 shows the SCT 3015R installation prompts in sequential order and indicates what ERG selected for testing by calibration type. Photographs [42] through [48] show screenshots for each prompt during the Ford testing installation.

**Table 7. Installation Prompts for the SCT 3015R Tuner**

| Step # | Prompt | Input Options | Option Selected for Testing | | Photo. # |
|---|---|---|---|---|---|
| | | | Emission-Equipment-Present Calibration | Emission Equipment-Remove Calibration | |
| 1 | Do you have a race exhaust installed? | • Yes<br>• No | No | Yes | 42 |
| 2 | Recalibrate speedometer for non-stock tire sizes? | • Yes<br>• No | No | No | 43 |
| 3 | Change axle gear ratio setting for non-stock gears? | • Yes<br>• No | No | No | 44 |
| 4 | Change tire pressure monitor system cold PSI setting? | • Yes<br>• No | No | No | 45 |
| 5 | Please select your engine power level | • Stock<br>• Street<br>• Tow<br>• Performance | Performance | Performance | 46 |
| 6 | Please disable or select your speed limit | • Stock<br>• Disable<br>• 60 MPH | Stock | Disable | 47 |
| 7 | Please select your trans power level | • Stock<br>• Performance | Stock | Stock | 48 |

For emissions equipment-removed testing, SCT's instructions do not clearly indicate what to do with sensors when installing emissions equipment-removed calibrations. On 2 December 2013, ERG called SCT technical support to ask whether or not to unplug the EGR harness. The SCT representative indicated that the tuner is only able to install calibrations that disable the EGR when installing a full EGR delete kit. Simply unplugging the EGR is not an option for this tuner and will cause the OBD to

illuminate the MIL and derate the engine.[15] The representative also confirmed that all sensors related to the aftertreatment system must remain plugged in but do not need to be installed in the aftertreatment system. Consequently, ERG left the EGR fully intact and functional for emission equipment-removed testing. ERG left all aftertreatment sensors plugged in (i.e., connected to the ECM) but did not reinstall them because the Flo-Pro aftertreatment delete pipe did not contain bungs (see Sections III.D and IV.B.2).

### 2. Flo-Pro Aftertreatment Delete Pipe Installation

Prior to emission equipment-removed testing, Ford installed the Flo-Pro DPF delete kit onto the test vehicle in the garage located in the testing facility. Photographs [14] and [49] show the Flo-Pro aftertreatment delete pipe out of the box and installed on the vehicle respectively. Ford removed the bolt-on exhaust section that included the oxidation catalyst, SCR, and DPF (in order from upstream to downstream). Photograph [20] shows the stock aftertreatment system that Ford removed and replaced for this portion of the testing. Prior to installing the delete kit, ERG installed a Spartan DPF-off tune onto the vehicle to prevent the OBD from derating the engine because Ford had to start the engine to move the vehicle from the garage to the testing area.

The Flo-Pro aftertreatment delete pipe did not contain any bungs for sensors but the stock aftertreatment system removed from the test vehicle contained bungs for the following sensors:

- Three EGT sensors;
- One pressure sensor;
- One NOx sensor; and
- One urea injector.

The instructions for each tuner require the user to do handle these sensors differently:

- Spartan 6.7 Phalanx: Remove from pipe but remain plugged in
- SCT 3015R: Remove from pipe but remain plugged in
- XRT Pro: Removed from pipe and unplugged.

During the Flo-Pro aftertreatment delete pipe installation, Ford left all sensors plugged into the harnesses as directed by the Spartan installation instructions. The sensors remained plugged in and tucked away for the SCT emissions equipment-removed testing. Prior to testing the XRT emissions equipment-removed calibration, Ford unplugged all sensors.

After successfully installing the aftertreatment delete kit and the Spartan emission equipment-removed calibration, Ford performed a transmission relearn on a nearby highway.[16] Due to logistics, this was the only opportunity to perform a transmission relearn during the entire testing week. However, Ford suggested that not performing a transmission relearn would not affect emissions performance but may cause some "harsh" shifting in the early phase testing after the transmission is recalibrated. In addition, the Spartan 6.7 Phalanx was the only tuner investigated by EPA that automatically calibrates the transmission and does not provide the user the option to calibrate the transmission during the installation process. Although the other tuners were capable, ERG and EPA decided to not calibrate the transmission for the other tuners.

[15] The SCT representative indicated that the user must indicate if they removed the EGR in the "adjustable options" tab on the main menu. However, ERG was unable to find this indicator in the adjustable options tab.
[16] Manufacturers recommend a transmission relearn whenever a transmission is recalibrated. A transmission relearn consists of a series of aggressive and non-aggressive accelerations.

EPA used this transmission relearn as an opportunity to demonstrate the Spartan tuner is capable of altering the OBD in a way that allows the vehicle to operate without any aftertreatment system. Photograph [50] and [51] show black smoke the vehicle generated from a hard acceleration during the transmission relearn.

### 3. OBD Scan Tool Data Procedure

After installation of each calibration and testing scenario, ERG immediately removed the tuner, connected an OBD II scan tool to the OBD II data link connector (DLC) on the test vehicle, and obtained vehicle data including DTCs, status of the MIL, Cal ID, and CVN. ERG used an AutoXray ® 4000 OBD II scan tool. ERG obtained this information for each tuner and calibration during the testing process:

- Before removing the ECM that was already installed on the vehicle from the previous test;
- After installing the new ECM that is assigned the tuner being tested;
- After installing the new calibration using the tuner being tested; and
- After returning the calibration to stock after the test cycle (if applicable).

The following describes each one of the parameters ERG recorded during testing. Section V.A summarizes the observations.

- Cal ID – The Cal ID represents the software version, which includes the engine data maps. A new calibration installation may or may not result in a new Cal ID depending on the tuner.
- CVN – The CVN is the result of a 'check-sum' calculation performed by the OBD system using the engine data maps as inputs. If the data values have not been changed or corrupted, the CVN will always provide the same sum for a given Cal ID. If the ECM has been modified or corrupted any of the calibration values, the CVN calculation will generate an incorrect 'sum'. ERG used this as the ultimate indicator that the tuner installed a new calibration between each test.
- DTCs – DTCs are codes that indicate a fault has been detected in one of the engine or emission systems. DTCs specifically indicate what system the fault was identified.
- MIL – The MIL, also known as the check engine light, is a symbol located near the odometer. The MIL indicator is amber (yellow) in color and should be illuminated for the first five seconds after the ignition key is turned on to show that the MIL light is working properly. After startup, the light is only illuminated when a malfunction is detected following the detection of DTCs. The MIL activates when monitored operating parameters indicate an engine component is malfunctioning to the point that the vehicle may be exceeding its applicable emission standards by certain thresholds.

### 4. Live Engine Data Logger Procedure

After ERG completed the calibration installation process, Ford installed an engine data logger into the OBD II DLC after ERG installed the new calibration and removed the tuner from the vehicle. To activate the device, Ford plugged the logger into the OBD II DLC. The logger begins recording the data when the vehicle engine speed (i.e., RPM) increases from zero after the engine is turned on. Ford set the data logger to record data at a rate of 60 hertz or one data point per second. Ford selected the parameters to record prior to ERG and EPA's arrival for testing the week of 2 December 2013. The list of parameters recorded are below (units are noted parenthetically).

Ford provided all logged data to ERG after the testing. ERG used the data to compare operating parameters that may affect emissions such as EGR, fueling rates, and fresh air flow. Section V.C summarizes ERG's analysis of the live engine data.

**Parameter List**

- Time (ms)
- RPM (RPM)
- Rel Pedal Angle (%)
- Vehicle Speed (MPH)
- Fresh Air Flow Mass (mg/hub)
- ASMOD EGR rate (%)
- Engine Coolant Temp (deg F)
- Inlet Air/Air Charge Temp (deg F)
- Engine Oil Temp (def F)
- EGR Valve Position (%)
- Engine Torque (Nm)
- Temp Downstream of DPF (deg C)
- Filter Restriction (hPa/(m^3/s))
- Percent Soot Load Regenerated (%)
- Condition of DPF (1 to 7)
- Regen Enable State (value)
- Engine Coordinator State (value)
- Exhaust Back Pressure (hPa)
- Post 1 Fuel Quantity (mg/hub)
- Post 2 Fuel Quantity (mg/hub)

**Parameter List (Continued)**

- Tailpipe NOx Sensor (ppm)
- UREA Command (mg/sec)
- Mass Fuel Desired (mg/hub)
- Engine Operating Mode (value)
- Throttle Angle (%)
- Low Temp Coolant Temp (deg C)
- Desired EGR Rate (%)
- UREA Tank Level (L)
- Rail_stCtlLoop* (RAM)
- Rail_stCPC* (RAM)
- Regen Request (value)
- Temp Upstream of DPF (deg C)
- Temp Upstream of DOC (deg C)
- IMAP (hPa)
- Temp Downstream of DOC (deg C)
- NH3 Stored in SCR (gm)
- Trans Gear Commanded (value)
- Exh Pressure Upstream of DPF (hPa)
- Distance Between Regens (miles)

### 5. Test Cycle Selection and Test Procedure at Ford

EPA's goal for this testing was to evaluate the relative change in emissions between the stock calibration (i.e., baseline) and calibrations from each tuner and, therefore, EPA did not use the FTP75 certification test cycle. Instead, Ford recommended running consecutive (FTP4-74 or US06) test cycles to complete a single test for each tuner calibration. Running consecutive test cycles ensured that at the beginning of the last test cycle in each test, the vehicle operating conditions (e.g., aftertreatment system temperature, engine oil temperature, coolant temperature) were consistent between tests thus providing comparable results. Consequently, EPA only compared results for the last phase of the test. Additionally, this allowed the testing to be completed in the limited time available[17].

The following subsections describe the two tests performed at Ford for the purpose of analyzing the effect of each calibration/tuner.[18] Section V.D summarizes the corresponding results for these tests.

#### a. FTP4-74

The FTP4-74 test cycle, also known as the Federal Test Procedure 74 or the Urban Dynamometer Driving Schedule, is designed to mirror city driving conditions simulating frequent starts and stops. The FTP4-74 test cycle has the same speed trace as the FTP72[19] cycle described in 40 CFR Part 86 Appendix I (a). Ford

[17] The FTP75 certification test cycle requires a 12-hour cold soak in a 75°F room prior to running the test which would have limited the number of tests Ford and EPA could run the week of testing.
[18] All information provided in this section is available on EPA's website at: http://www.epa.gov/nvfel/testing/dynamometer htm.
[19] The FTP75 and the FTP72 are two variations of the EPA Urban Dynamometer Driving Schedule. The FTP75 is the successor of the FTP72 and is derived from the FTP72 by adding a third 505 second phase to the test cycle that is identical to the first phase of FTP72. The FTP75 is also described in 40 CFR Part 86 Appendix I (a).

stated that the difference between the FTP4-74 test cycle and the FTP72 test cycle is that the FTP72 test cycle requires a 12 hour "cold soak" at 75 degrees Fahrenheit prior to testing. Table 8 describes the FTP4-74 test cycle in more detail. Figure 1 shows the speed trace of a single FTP4-74 test cycle. As shown in Figure 1 and Table 8, each FTP4-74 test cycle has two phases.

For each calibration and tuner FTP4-74 test, Ford completed the following procedure:

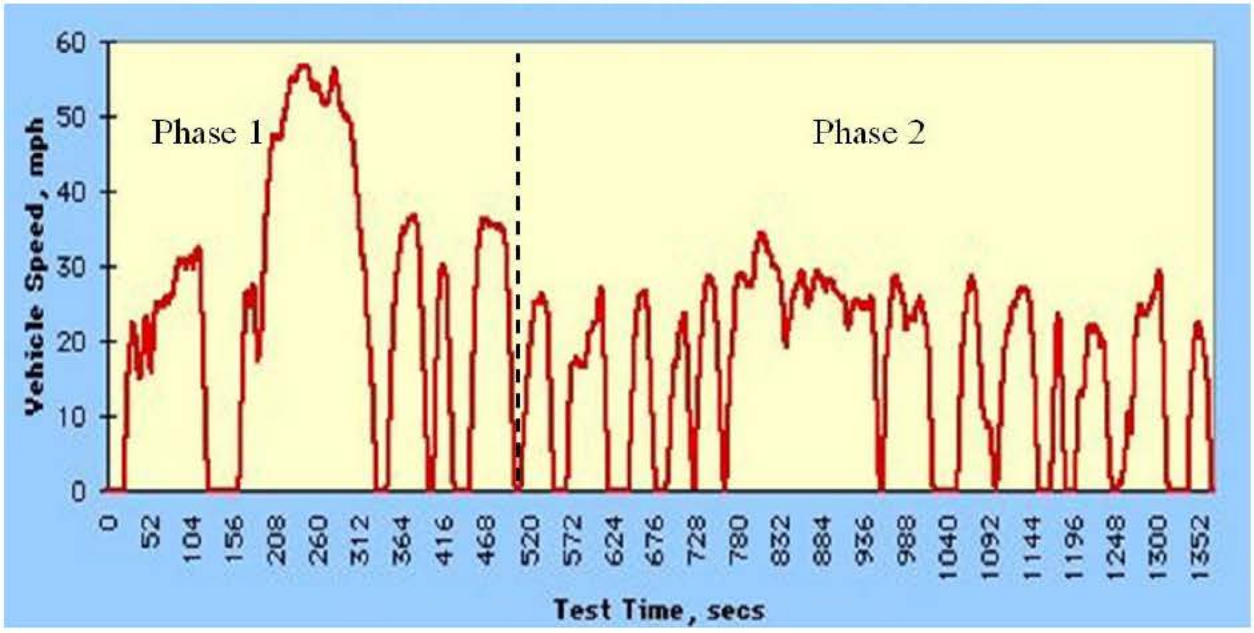
1. Performed one FTP4-74 test cycle when the engine was cold
2. Allowed a 10 minute engine off period
3. Performed a second FTP4-74 test cycle
4. Performed a third FTP4-74 test cycle (ERG only used the result from this cycle for evaluating how each calibration affected emissions in Section V.D). A short engine-on idle period occurred between Steps 3 and 4 above, as specified in the FTP speed trace, at the end and beginning of each FTP4-74 test cycle.

Ford recommended only using the third FT4-74 test cycle result as the valid result. This ensures that the vehicle's engine and emission control devices were at "steady state" operating temperature at the beginning of third and valid test.

**Table 8. FTP4-74 Test Cycle Description**

| Parameter | Description | |
|---|---|---|
| Description | Normal city driving | |
| One FTP4-74 test cycle | Phase 1 ("cold start")[a] | ~3.6 miles<br>505 seconds |
| | Phase 2 ("stabilization phase") | ~3.9 miles<br>867 seconds |
| | Total test cycle | ~ 7.5 miles<br>1372 seconds |

a – Although this is typically described as a "cold start", it was actually a hot start by the third consecutive test cycle during each FTP4-74 test Ford conducted the week of 2 December 2013.



Source: EPA (OTAQ)[20]

**Figure 1. One FTP4-74 Test Cycle Speed Trace**

**b. US06**

The US06 test cycle is also known as the Supplemental Federal Test Procedure (SFTP) which was to address the shortcomings with the Urban Dynamometer Driving Schedule. It captures aggressive, high speed and/or high acceleration driving behavior, rapid speed fluctuations, and driving behavior following startup. Table 9 describes the US06 test cycle in more detail. Figure 2 shows the speed trace of a single US06 test cycle which is available in 40 CFR Part 86 Appendix I (g).

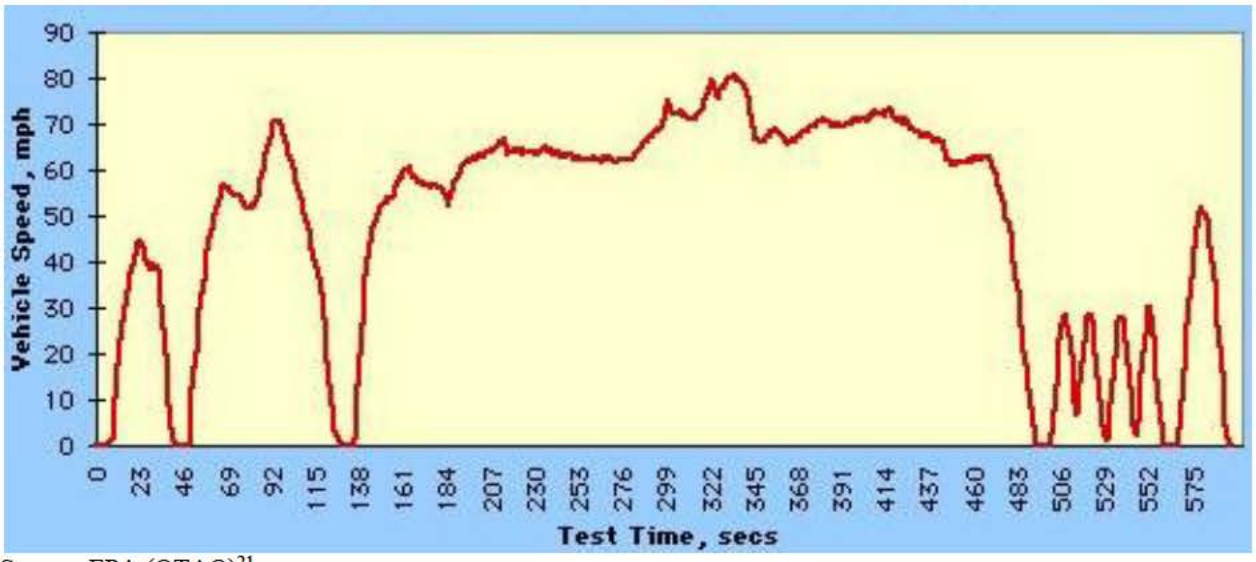
For each calibration and tuner US06 test, Ford completed the following procedure:

1. Performed one US06 test cycle when the engine was cold
2. Performed a second US06 test cycle (ERG only used the result from this cycle for evaluating how each calibration affected emissions in Section V.D). A short engine-on idle period occurred between steps 1 and 2, as specified in the FTP speed trace, at the end and beginning of each US06 test cycle.

Ford recommended only using the second US06 test cycle result as the valid result to ensure that the vehicle's engine and emission control devices were at "steady state" operating temperature at the beginning of the second and valid test.

**Table 9. US06 Test Cycle Description**

| Test Scenario | US06 | |
|---|---|---|
| Description | Hard city driving | |
| Breakdown of test cycle | Only 1 phase | ~8 miles<br>~600 seconds |




Source: EPA (OTAQ)[21]

**Figure 2. US06 Test Cycle Speed Trace**

[20] Adapted from EPA OTAQ website. Available online at: http://www.epa.gov/nvfel/methods/ftpdds.gif
[21] Available online at: http://www.epa.gov/nvfel/methods/uddsdds.gif.

## V. FORD TESTING RESULTS

The following subsections summarize the results and observations from the emissions testing at Ford. Section A describes observations of general diagnostic information reported through the OBD. Section B presents Bosch's analysis of the ECMs after testing. Section C presents ERG's analysis of live engine data obtained during the testing. Section D Presents the measured emissions results from the Ford testing.

### A. OBD Scan Tool Data Observations

After installation of each calibration and testing scenario, ERG immediately removed the tuner, connected an OBD II scan tool[22] to the OBD II DLC on the test vehicle, and obtained vehicle data. ERG observed DTCs, the status of the MIL, Cal ID[23], and CVN.[24] After each emission testing each calibration, ERG returned the ECM to stock and observed the same data. Table 10 shows the data obtained through the OBD DLC after each set of tests. It is important to note that when a tuner is unplugged, the most recent calibration remains installed on the ECM along with any software modifications.

#### 1. Cal ID and CVN

EPA's OBD scan tool reported "33EC57FE" for the stock calibration on all three ECMs that Ford provided.[25] Observations shown in Table 10 show that:

- The Spartan and H&S tuners altered the Cal IDs for each calibration modification.
- The SCT tuner did not alter the Cal ID.

For all tuner calibrations, the observed CVNs changed from the stock CVN confirming that the tuners modified engine data maps in some way. Also for all tuner calibrations, the ECM Cal ID and CVN matched the certified values after returning the ECM to stock, verifying that the each tuner successfully returns the ECM to its stock calibration with no obvious trace of modification.

#### 2. DTCs and MIL

For all tuners, after installing each emissions equipment-present calibration and starting the engine, the OBD II scan tool reported the MIL as "off" and no DTCs were present. Ford verified that none of the emissions equipment-present calibrations should have triggered a DTC or the MIL. However, Ford confirmed that with the aftertreatment system removed, the OBD would immediately trigger DTCs, illuminate the MIL, and shut off the engine if started with a stock calibration. After each of the emissions equipment-removed calibrations were installed, no DTCs were triggered and the MIL status was always "off" indicating that all tuners deliberately disable functions of the OBD.

Between installations of emissions-removed calibrations from different tuners, ERG observed DTCs and the MIL status as "on" while the ECM was temporarily in its stock configuration and the aftertreatment system as removed verifying what Ford reported. These observations varied by tuner. For example, ERG

[22] The OBD scan tool was an AutoXray ® 4000.
[23] The Cal ID represents the software version, which includes the engine data maps.
[24] The CVN is the result of a 'check-sum' calculation performed by the OBD system using the engine data maps as inputs. If the data values have not been changed or corrupted, the CVN will always provide the same sum for a given Cal ID. If the ECM has been modified or corrupted any of the calibration values, the CVN calculation will generate an incorrect 'sum'.
[25] Ford provided all ECMs with exactly the same calibrations: Cal ID 1: BC3A – 14C204-FAA and Cal ID 2: DDBN3C3.H32. However, EPA's scan tool read the first calibration slightly different as BC3A-14D609-AD. For the purpose of this testing, ERG assumed BC3A-14D609-AD is equivalent to the stock calibration reported by Ford. The second observed calibration matched the second calibration reported by Ford: DDBN3C3.H32.

observed no DTCs related to the EGR after returning the ECM to stock from the Spartan emission equipment-removed calibration because the Spartan tuner does not require the user to unplug or remove the EGR to disable it. However, ERG did observe emission control related DTCs after returning the H&S XRT Pro to stock because ERG unplugged all EGR and aftertreatment sensors.

## Table 10. OBD Scan Tool Observations

| Tuner | Calibration | MIL Status | DTC Count | Cal ID 1 (Calibration Name) | Cal ID 2 (Cal ID) | CVN 1 |
|---|---|---|---|---|---|---|
| Spartan | Stock[a] | Off | 0 | DDBN3C3.H32 | BC3A-14D609-AD | 33EC57FE |
| | Emissions Equipment-Present[b] | Off | 0 | SPRTENG.H32 | BC3A-12B533-AD | 1B828E73 |
| | Returned to Stock[c] | Off | 0 | DDBN3C3.H32 | BC3A-14D609-AD | 33EC57FE |
| | Emissions Equipment-Removed[d] | Off | 0 | SPRTENG.H32 | BC3A-12B533-AD | C50A6DD6 |
| | Returned to Stock[e] | Off[g] | 0 | DDBN3C3.H32 | BC3A-14D609-AD | 33EC57FE |
| XRT Pro | Stock[a] | Off | 0 | DDBN3C3.H32 | BC3A-14D609-AD | 33EC57FE |
| | Emissions Equipment-Present[b] | Off | 0 | DDBM3CZ.H32 | BC3A-12B533-AD | BE884C2F |
| | Returned to Stock[c] | Off | 0 | DDBN3C3.H32 | BC3A-14D609-AD | 33EC57FE |
| | Emissions Equipment-Removed[d] | Off | 0 | DDBM3CZ.H32 | BC3A-12B533-AD | DF0E6518 |
| | Returned to Stock[e] | Off[g] | 11 | DDBN3C3.H32 | BC3A-14D609-AD | 33EC57FE |
| SCT | Stock[a] | Off | 0 | DDBN3C3.H32 | BC3A-14D609-AD | 33EC57FE |
| | Emissions Equipment-Present[b] | Off | 0 | "Not Supported"[f] | "Not Supported" | A03A2541 |
| | Returned to Stock[c] | Off | 0 | DDBN3C3.H32 | BC3A-14D609-AD | 33EC57FE |
| | Emissions Equipment-Removed[d] | On[h] | 1 | DDBN3C3.H32 | BC3A-14D609-AD | 86E782D7 |
| | Returned to Stock[e] | Off[g] | 0 | DDBN3C3.H32 | BC3A-14D609-AD | 33EC57FE |

a - This OBD data was observed prior to any testing.
b - This OBD data was observed after each ECM was calibrated to the emissions equipment-present calibration.
c - This OBD data was observed after each ECM was returned to its stock calibration immediately after emissions equipment-present testing.
d – This OBD data was observed after each ECM was calibrated to the emissions equipment-removed calibration.
e - This OBD data was observed after each ECM was returned to its stock calibration immediately after emissions equipment-removed testing.
f – The SCT tuner reported the strategy as "DDBN3C3" after the emissions equipment-present calibration was installed but the scan tool reported "not supported".
g – ERG was did not start the engine after each ECM was returned to stock from emission equipment-removed calibrations because the aftertreatment system was still removed. According to Ford, starting the engine with the stock ECM would result in engine derating.
h – The MIL turned on during this test. The triggered DTC was P167F: "Non-OEM Calibration Detected". However, vehicle continued to operate normally.

## B. Analysis of Engine Data Maps by Bosch

As described in Section IV.B.1, Ford supplied three different ECMs for testing such that ERG installed the calibrations from each tuner onto a designated ECM. On 6 December 2013, ERG left each ECM in a specific calibration determined by EPA so that Bosch, Ford's ECM supplier, could compare the stock calibration file against the tuner calibration file. Appendix F provides the engine data map results as reported to ERG by Ford after the testing.

Table 11 lists the engine data map parameters that the tuner calibration altered as reported by Ford/Bosch after the testing. Asterisks indicate parameters that are of concern in respect to emissions. In addition to observing the alterations to data maps described in Table 11, Bosch/Ford also observed changes to data stream label names. Appendix F also provides a complete list of the data streams that involved a label change.

**Table 11. Summary of Calibration File Compare by Bosch**

| Tuner | Calibration Type | Parameter | Observed Changes in Calibration |
|---|---|---|---|
| Spartan 6.7 Liter Phalanx (ECM Serial Number: 260310-2593) | Emissions equipment-present | Fuel quantity* | Increases |
| | | Rail pressure* | Increases |
| | | Smoke limit* | Allows lower air-to-fuel-ratio (fuel rich) |
| | | Fuel injection timing* | Advanced timing by 5 degrees at higher torque demands |
| | | Compoent protection[a] | Increased T3 limit from 800 to 900 DegC |
| | | Driver demand | Moved to upper bounds |
| | | Disable codes | VID Block |
| | | Max engine speed | Moved from 3,800 to 4,000 |
| | | Engine protect | Moved torque and fuel to max allowed |
| | | Max vehicle speed | Moved to max allowed |
| H&S XRT Pro (ECM Serial Number: 260210-0143) | Emissions equipment-present | Fuel quantity * | Increased during the fuel injector energizing time |
| | | Fuel Injection timing* | Advanced timing by 2 degrees at higher torque demands |
| | | Smoke limit* | Allows lower air-to-fuel-ratio (fuel rich) |
| | | Compoent protection[a] | Moved T3 way out |
| | | Lug curve | Moved out of the way |
| | | Driver demand | Increased torque early on in pedal |
| | | Disabled codes | -- |
| | | Max engine speed | Increased from 3,800 to 4,500 rpm |
| | | Engine protect | Eliminated overheat threshold for coolant and oil |
| | | Max vehicle speed | Moved to max allowed |
| SCT 3015R (ECM Serial Number[a]: 160210-1855) | Calibration returned to stock | No changes observed | |

"--" no description provided.
a—The summary ERG received from Ford reported "Compoent" but it was likely meant to be "component".

## C. Live Engine Data

During the testing, Ford logged live engine operating data by connecting a Ford data logger directly to the OBD II data link connector. Ford provided ERG all of the recorded data after testing. ERG analyzed engine parameters that can potentially affect emissions performance if altered from the designed operating range including:

- EGR (%);
- Total urea consumption;
- Total fuel consumption; and
- Cumulative air-to-fuel ratio (AFR).

The following subsections describe the calculations ERG made and the summary of results.

### 1. Methodology

The raw data from Ford included a value for each engine parameter over time at the rate of 1 hertz, or 1 data point per second. ERG calculated ranges, medians, and cumulative totals for the aforementioned data streams using Microsoft Excel. For this analysis, ERG excluded all data points logged before the vehicle speed increased from zero at the beginning of testing and all data points after the vehicle speed reached zero at the end of the testing. This was done because the data logger often started logging data immediately after engine start up and not when the actual test cycle commenced (i.e., the vehicle was put into drive). By eliminating the excess data before the vehicle moved and after the vehicle stopped, ERG was able to compare data sets on an equivalent basis (e.g., same length of time).

EGR

ERG evaluated the data stream called "ASMOD EGR rate" in order to investigate if the tuners disable the EGR system function. The "ASMOD EGR rate" data stream represents the recirculated exhaust gas flow as a percentage of total intake volume. The ECM calculates this data stream by converting the measured delta pressure to mass flow rate downstream of the EGR cooler just prior to the engine intake. The ECM uses the fresh air and/or total intake mass flow rate to convert this mass flow rate to a percentage of total intake volume.

Ideally, ERG would use the actual EGR valve position data stream, but the Spartan emissions equipment-present calibration defaulted this data stream to zero. Ford confirmed that the ASMD EGR rate provides a valid measurement for approximate EGR flow.

Urea consumption

ERG evaluated the data stream called "Urea Command" in order to investigate if the tuners disable the SCR system function. The "urea command" data streams represent instantaneous urea consumption in mg per second. ERG used Equation 1 to convert the instantaneous rate to cumulative urea consumption for each test.

**Equation 1**

$$Cumulative\ Urea\ (mg) = \sum \boldsymbol{Urea_{Inst}} \left(\frac{mg}{second}\right) \times \Delta \boldsymbol{Time}$$

Note: Bold values in the equations are data streams as reported in the raw engine data.

Cumulative Average AFR (and Fuel Consumption)

ERG used several individual data streams to calculate the cumulative AFR. ERG analyzed AFR because any increase or decrease in AFR from stock will potentially affect emissions. As described below, this included the calculation of cumulative fuel consumption and fresh air flow. ERG specifically evaluated fuel consumption in this report because we expected the tuning devices to alter the fueling rates as opposed to fresh air rates. In addition, a significant increase in AFR is an indicator that the EGR has been turned off because the volume within the cylinder that is typically displaced by recirculated exhaust gas is replaced with fresh air.

Although the raw data did include instantaneous air and fuel flow rates necessary to calculate instantaneous AFR, ERG did not analyze instantaneous AFRs due to potential time lag differences between air and fuel rates.[26] Instead, ERG integrated the instantaneous fuel mass rate ($Fuel_{inst}$) and instantaneous intake air mass flow ($Fresh\ Air_{inst}$) across each time increment ($\Delta Time$) to calculate the cumulative air and fuel flow for the entire test cycle and then subsequently calculated the cumulative average AFR. Furthermore, the raw data reported fuel flow rate in units of mass per stroke which required conversion to mass per unit time using other data reported. ERG used Equation 2 and Equation 3 to convert the reported fuel and fresh air mass per stroke to cumulative values respectively. These equations convert the reported mass per stroke to mass per unit time and then integrate the instantaneous mass flow rate to calculate the cumulative values for each test cycle. Equation 4 calculates the cumulative AFR using the results from Equation 2 and Equation 3.

**Equation 2**

$$Cumulative\ Fuel\ (mg) = \sum \boldsymbol{RPM_{inst}} \left(\frac{revoltions}{ms}\right) \times \boldsymbol{Fuel_{inst}} \left(\frac{mg}{stroke}\right) \times \left(\frac{2\pi}{revolution}\right) \times \left(\frac{180\ degrees}{\pi}\right) \times \left(\frac{1\ stroke}{720\ degrees/cylinder}\right) \times 8\ (cylinders)\ \times\ \boldsymbol{\Delta Time}$$

**Equation 3**

$$Cumulative\ Air\ (mg) = \sum \boldsymbol{RPM_{inst}} \left(\frac{revoltions}{ms}\right) \times \boldsymbol{Fresh\ Air_{inst}} \left(\frac{mg}{stroke}\right) \times \left(\frac{2\pi}{revolution}\right) \times \left(\frac{180\ degrees}{\pi}\right) \times \left(\frac{1\ stroke}{720\ degrees/cylinder}\right) \times 8\ (cylinders)\ \times\ \boldsymbol{\Delta Time}$$

**Equation 4**

$$Cumulative\ AFR\ (kg{:}\ kg) = \frac{Cumulative\ Air\ (kg)}{Cumulative\ Fuel\ (kg)}$$

Note: Bold values in the equations are data streams as reported in the raw engine data.

## 2. Summary of Live Data Results

Table 12 presents the values ERG calculated for the live engine data logged by Ford by tuner, calibration type, and parameter. Table 13 summarizes these statistics in comparison to the baseline FTP4-74 test by tuner and calibration type. Due to logistics, Ford was unable to log data for the US06 baseline test. Due to the lack of duplicate tests, ERG was unable to determine typical repeatability for these data streams. Despite having no duplicate data logger results, it reasonable that the some of the changes summarized in Table 13 are statistically measureable. Statistically measurable results are highlighted red. It is possible

[26] A very small time lag (less than a second) can cause an inaccurate instantaneous AFR.

that the other measured increases are also statistically measureable, but there are no duplicate results to confirm. These results are highlighted yellow.

**Table 12. Live Engine Data Observations**

| Tuner | Parameter | Value Type | FTP4-74 Test | | | US06 Test | |
|---|---|---|---|---|---|---|---|
| | | | Baseline | Emissions Equipment-Present | Emissions Equipment-Removed | Baseline | Emissions Equipment-Present |
| Spartan 6.7 Liter Phalanx | EGR Air System Model (%) | Range | 0 – 54 | 2 – 55 | 0 | No Data[d] | 0 – 54 |
| | | Median | 37 | 38 | 0 | | 27 |
| | Urea (g) | Total | 17 | 22 | 0 | | >27[a] |
| | Fuel (kg) | Total | 1.72 | 1.72 | 1.52 | | >1.62 |
| | AFR (kg/kg) | Cum. Average | 30 | 31 | 55 | | ~28[a] |
| H&S XRT Pro | EGR Air System Model (%) | Range | 0 – 54 | No data[b] | 0 | | Not tested[c] |
| | | Median | 37 | No data[b] | 0 | | Not tested[c] |
| | Urea (g) | Total | 17 | No data[b] | 0 | | Not tested[c] |
| | Fuel (kg) | Total | 1.72 | No data[b] | 1.64 | | Not tested[c] |
| | AFR (kg/kg) | Cum. Average | 30 | No data[b] | 52 | | Not tested[c] |
| SCT 3015R | EGR Air System Model (%) | Range | 0 – 54 | 0 – 54 | 0 – 53 | | 0 – 55 |
| | | Median | 37 | 39 | 40 | | 26 |
| | Urea (g) | Total | 17 | 12 | 0 | | 29 |
| | Fuel (kg) | Total | 1.72 | 1.53 | 1.44 | | 1.82 |
| | AFR (kg/kg) | Cum. Average | 30 | 33 | 34 | | 30 |

a – The first 30 seconds of the test was not recorded by the data logger.
b – Ford did not use a data logger for this test.
c – The XRT was not tested on the US06 test.
d – Ford was unable to obtain data from the data logger for the baseline US06 test.

**Table 13. Summary of Live Engine Data Observations on the FTP4-74 Test**

| Tuner | Calibration Type | Observed Changes in Measured Operating Parameters |
|---|---|---|
| Spartan 6.7 Liter Phalanx | Emissions equipment-present | • Urea consumption increased |
| | Emissions equipment-removed | • EGR eliminated<br>• Urea consumption eliminated<br>• Cumulative AFR increased significantly because of elimination of EGR |
| | | • Fuel consumption decreased |
| H&S XRT Pro | Emissions equipment-present | --[a] |
| | Emissions equipment-removed | • EGR eliminated<br>• Urea consumption eliminated<br>• Cumulative AFR increased significantly because of elimination of EGR |
| | | • Fuel consumption decreased |
| SCT 3015R | Emissions equipment-present | • Urea consumption decreased<br>• Fuel consumption decreased<br>• Cumulative AFR increased |
| | Emissions equipment-removed | • Urea consumption eliminated |
| | | • Fuel consumption decreased<br>• Cumulative AFR increased |

a – The data logger was not used for this test.

## D. Measured Emissions Results

The following sections summarize the results from emissions testing at Ford's testing facility using an engine dynamometer the week of 2 December 2013. Ford measured $NO_x$, PM, CO, NMHC, and fuel economy for each tuner model and calibration type on the US06 and FTP4-74 tests. For CO and $NO_x$, Ford provided both system out (SO) values, which represents tailpipe emissions, and engine out (EO) values, which represents emissions prior to aftertreatment. Ford was able to estimate the EO emissions by inserting a probe immediately downstream of the turbo charger, prior to aftertreatment. EO results represent modal measurements and SO results represent bag measurements.[27] EO values were not measured for PM and NMHC or when emission equipment was removed. Ford did not measure EO values when emission equipment was removed because the section of the exhaust system that contained the probe was removed in order to install the aftertreatment delete pipe.

### 1. US06 Test (Emissions Equipment-Present Only)

Ford conducted US06 tests on the Spartan and SCT tuners in addition to duplicate baseline US06 tests with a stock calibration. This section is divided into two parts: US06 test results (Section V.D.1.a) and US06 baseline test results (Section V.D.1.b). Section V.D.1.a summarizes the test results with the tuners installed and V.D.1.b summarizes the duplicate baseline test results and how ERG used them.

#### a. US06 Test Results (Emissions Equipment-Present Only)

Table 14 present test results for $NO_x$, PM, CO, NMHC, and fuel economy for the US06 test. Results are categorized by tuner model and calibration type.

Red highlighted results – The red highlighted results shown in Table 14 are statistically significant increases over the mean baseline result. These results include the EO and SO CO measured with the Spartan and SCT tuners. For the purpose of US06 test results only, ERG classified these results as significant using the statistical analysis described in Section V.D.1.b with the assumption that the emissions measurement variability is relative to the magnitude of the emissions values.[28]

Yellow highlighted result – The yellow highlighted PM result for the Spartan tuner shown in Table 14 is a potential increase over the mean baseline PM result. ERG classified this result as such using the statistical analysis described in Section V.D.1.b on a regular (i.e., non-log) scale.[29]

[27] For each test, Ford used the same dynamometer calibration settings including an inertia of 11,000 pounds, "Road Load A" of 53.79 pounds, "Road Load B" of -0.6331 pounds, and "Road Load C" of 0.05883. Each test Ford performed used the same exact fuel identified "DIES_720-A" in the raw result files.

[28] The assumption of relative errors in measured emissions was made by conducting this statistical analysis on the natural logs of the measured emissions values. This approach conservatively assumes that variability of measurements increases relative to the measured result.

[29] Conducting this statistical analysis on a regular (i.e., non-log) scale is less conservative and assumes that variability of measurements does not increase relative to the measured result.

**Table 14. US06 Test Results for Model Year 2011 6.7 Liter Powerstroke Vehicle at Ford with the Spartan 6.7L Phalanx and SCT 3015R Tuners**

| Tuner | Test Scenario | EO NOx | | SO NOx | | SO NMHC | | EO CO | | SO CO | | PM | | Fuel Economy | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (mpg) | % Diff[a] |
| Spartan | Mean baseline | 3.621 | -- | 1.6053 | -- | 0.0060 | -- | 2.823 | -- | 0.0096 | -- | 0.0012 | -- | 12.06 | -- |
| | Equip-Present[b] | 3.118 | -14 | 1.2191 | -24 | 0.0012 | -80 | 4.205 | 49 (8.6)[f] | 0.4550 | 4,664 (111)[f] | 0.0072[e] | 526 (5.0)[f] | 12.14 | 1 |
| SCT | Mean baseline | 3.621 | -- | 1.6053 | -- | 0.0060 | -- | 2.823 | -- | 0.0096 | -- | 0.0012 | -- | 12.06 | -- |
| | Equip-Present[b] | 3.162 | -13 | 0.5287 | -67 | 0.0042 | -29 | 5.059 | 79 (14)[f] | 0.7152 | 7,389 (175)[f] | 0.0014 | 22 (0.2)[f] | 12.23 | 1 |

EO – Engine Out
SO – System Out (tailpipe)
Red – Statistically significant increase from baseline
Yellow – Potential increase from baseline
a – Percent difference of the result compared to baseline (or stock OEM). Negative values represent decreases. Positive values represent increases.
b –Emissions equipment-present calibration
c –Emissions equipment-removed calibration
d – No EO data was available when emission equipment was removed.
e –As described in Section IV.B, Ford stated the results from second consecutive US06 test cycle during each US06 test should be considered the valid result. Due to a procedural reporting error, this test result was inadvertently reported as the Phase 1 result rather than the Phase 2 result. However, Ford confirmed after the testing that this test result was, in fact, for Phase 2.
f – Values in parenthesis represent the increase in terms of number of standard deviations over the mean baseline result. Additional statistical data for duplicate baseline tests are shown in V.D.1.b.

### b. Duplicate US06 Baseline Test Results

Replicate measurements can be used to estimate the statistical significance of differences in the emissions measurements as a consequence of modifying the stock calibration through the use of the tuners. Ideally, replicate measurements would be made for both the baseline and the modified configurations. However, due to logistics, replicate test results were only obtained for the US06 baseline test with the stock calibration and not when the ECMs were modified using the tuners. Therefore, variability is unknown when the ECMs were in a "tuned" state.

An alternative approach to collecting actual replicate measurements for the modified calibrations is to make an assumption about how the variability is related to the observed measurement. Two options that may be used include: 1) assume the magnitude of the measurement variability is the same for all configurations regardless of the measured value (absolute variability), and 2) assume the magnitude of the measurement variability increases as the magnitude of emissions increases (relative variability). ERG analyzed the significance of US06 test results using both options:

- Option 1: ERG classified a measured result in Table 14 as a potential increase from baseline (yellow highlight in Table 14) if it passes the statistical test described below without using a natural log scale. This is less conservative than option 2 and assumes that variability of measurements does not increase relative to the measured result. For example, this assumes that the 0.004 grams per mile standard deviation for CO calculated for the baseline US06 test would be exactly the same on the US06 test when the ECM is calibrated with one of the tuners despite the fact that the measured CO increased by up to 7,000 percent over baseline
- Option 2: As explained in Section V.D.1.a, ERG only classified a measured US06 test result as a significant increase from baseline (red highlight in Table 14) if it passes the statistical test described below on a natural log scale. On a natural log scale, the criterion for determining if an increase is statistically significant becomes more stringent. Conducting this statistical analysis on a log scale conservatively assumes that the variability of measurements increases relative to the measured result.

ERG used the statistical test called the "one-sided t-test"[30] to determine if the measured increase is statistically greater than the mean baseline. For each measured parameter, ERG followed the following procedure:

1. ERG used Equation 5 to calculate the relative percent difference of the base results. Note that this value is not used in any subsequent calculations and is shown for context.
2. ERG used Equation 6 to calculate the standard deviation of the baseline results.
3. ERG used Equation 7 to calculate a criterion, defined as μ, based on the number of baseline samples and the standard deviation of the mean baseline results.
4. ERG determined if Equation 8 is true. If the result of Equation 8 is true, ERG determined that this test result is statistically greater than the mean baseline test result.

**Equation 5**

$$Relative\ Percent\ Difference = \frac{|x_1 - x_2|}{\bar{x}}$$

**Equation 6**

$$SD = \sqrt{\frac{\Sigma\,(x_i - \bar{x})^2}{(n-1)}}$$

[30] Test procedure from National Bureau of Standard's *Experimental Statistics* (August 1, 1963).

**Equation 7**

$$\mu = t_{0.95} \times \frac{SD_i}{\sqrt{n}}$$

**Equation 8**

$$m_i - \bar{x} > \mu$$

Where:
$\mu$ = criterion for significance ~ 4.5
$t_{0\,95}$ = t value for 95 percent confidence = 6.314[31]
n = number of duplicate baseline results = 2
$SD_i$ = Standard deviation of the duplicate baseline results for each parameter
$x_1$ = 1st baseline result
$x_2$ = 2nd baseline result
$x_i$ = individual baseline result
$\bar{x}$ = the mean baseline result
$m_i$ = measured parameter result of sample "i"

Table 15 provides the results for the two US06 baseline tests in grams per mile along with the calculated mean, the standard deviation of the two US06 baseline test results, and the standard deviation of the baseline results. To allow an examination of significant differences under the assumption that variability increases relative to the measured result, Table 16 provides the same statistics as Table 15 on a natural log scale.

**Table 15 Results for Duplicate US06 Baseline Tests (Absolute Scale)**

| Parameter | 1st US06 Baseline Test Result (g/mile[a]) | 2nd US06 Baseline Test Result (g/mile[a]) | Relative Percent Difference (%) | Mean US06 Baseline Test Result (g/mile[a]) | Standard Deviation (g/mile[a]) | μ (g/mile[a]) |
|---|---|---|---|---|---|---|
| EO NOx | 3.461 | 3.781 | 9% | 3.621 | 0.2263 | 1.010 |
| SO NOx | 1.556 | 1.655 | 6% | 1.605 | 0.0701 | 0.3129 |
| SO NMHC | 0.0068 | 0.0051 | 29% | 0.0060 | 0.0012 | 0.0054 |
| EO CO | 2.937 | 2.709 | 8% | 2.823 | 0.1612 | 0.7198 |
| SO CO | 0.0067 | 0.0124 | 60% | 0.0096 | 0.0040 | 0.0180 |
| SO PM | 0.0003 | 0.0020 | 148% | 0.0012 | 0.0012 | 0.0054 |
| Fuel Economy (mpg) | 12.17 | 11.94 | 2% | 12.06 | 0.1650 | 0.7368 |

a – Unless otherwise noted.

[31] It is important to note that as the number of samples increases $t_{0\,95}$ becomes less stringent. For example, if the number of duplicate test results increases from two to three, $t_{0\,95}$ decreases from 6.314 to 2.920.

**Table 16. Results for Duplicate US06 Baseline Tests (Log Scale)**

| Parameter | log of 1st US06 Baseline Test Result (g/mile[a]) | log of 2nd US06 Baseline Test Result (g/mile[a]) | Relative Percent Difference (%) | Mean of log of US06 Baseline Test Result (g/mile[a]) | Standard Deviation (g/mile[a]) | μ (g/mile[a]) |
|---|---|---|---|---|---|---|
| EO NOx | 1.242 | 1.330 | 7% | 1.286 | 0.0625 | 0.2792 |
| SO NOx | 0.4419 | 0.5037 | 13% | 0.4728 | 0.0437 | 0.1950 |
| SO NMHC | -4.991 | -5.279 | 6% | -5.135 | 0.2034 | 0.9082 |
| EO CO | 1.077 | 0.9966 | 8% | 1.037 | 0.0571 | 0.2551 |
| SO CO | -5.006 | -4.390 | 13% | -4.698 | 0.4353 | 1.943 |
| SO PM | -8.112 | -6.215 | 26% | -7.163 | 1.342 | 5.989 |
| Fuel Economy (mpg) | 2.500 | 2.480 | 1% | 2.490 | 0.0137 | 0.0611 |

a – Unless otherwise noted.

### 2. FTP4-74 Test

Ford conducted FTP4-74 tests on all tuners in addition to one baseline FTP4-74 test. Table 17 present the test results for $NO_x$, PM, CO, NMHC, and fuel economy for the FTP4-74 test. Results are categorized by tuner model and calibration type. Because testing included FTP4-74 test for both emissions equipment-present and –removed, this section is divided into two parts.

#### a. Emissions Equipment-Removed

The red highlighted results shown in Table 17 are large increases[32] over the baseline results. This includes all measured emissions for all tuners when emissions equipment was removed. It is important to note that smallest relative increase of emissions was approximately 4,000 percent and increases as high as 114,000 percent were observed. In addition, the measured increases for all three tuners for each measured parameter were similar. For example, measured NMHC increased by approximately 100,000 percent for all three tuners. The only parameter that did not increase the same was $NO_x$ with the SCT tuner. This can be explained by the fact that the SCT tuner does not electronically disable the EGR system like the other two tuners. However, the SCT tuner still resulted in a 4,000 percent increase in SO $NO_x$ due to the absence of the SCR system.

#### a. Emissions Equipment-Present

The yellow highlighted results shown in Table 17 are all potential increases measured over the baseline result. ERG was unable to specifically classify any emissions equipment-present results as increases due to the following reasons:

- No historical variability data for the FTP4-74 test cycle with this engine family are available;
- No duplicate test results are available; and
- Some SO and EO increases were inconsistent (e.g., EO and SO CO measurements for SCT).

[32] The statistical significance of these increases were not determined since replicate emissions measurements during FTP4-74 testing were not available.

**Table 17. FTP4-74 Test Results for Model Year 2011 6.7 Liter Powerstroke Vehicle at Ford at Ford with All Tuners**

| Tuner | Test Scenario | EO NOx | | SO NOx | | SO NMHC | | EO CO | | SO CO | | PM | | Fuel Economy | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (g/mi) | % Diff[a] | Result (mpg) | % Diff[a] |
| Spartan | Baseline | 1.036 | -- | 0.0303 | -- | 0.0005 | -- | 5.384 | -- | 0.0255 | -- | 0.0017 | -- | 13.16 | -- |
| | Equip-Present[b] | 1.087 | 5 | 0.0579 | 91 | 0.0005 | 0 | 5.035 | -6 | 0.0269 | 5 | 0.0025 | 47 | 13.54 | 3 |
| | Equip-Removed[c] | --[d] | --[d] | 10.5344 | 34,667 | 0.5678 | 113,460 | --[d] | --[d] | 3.3177 | 12,911 | 0.0649 | 3,718 | 14.58 | 11 |
| XRT | Baseline | 1.036 | -- | 0.0303 | -- | 0.0005 | -- | 5.384 | -- | 0.0255 | -- | 0.0017 | -- | 13.16 | -- |
| | Equip-Present[b] | 0.986 | -5 | 0.0107 | -65 | 0.0005 | 0 | 5.107 | -5 | 0.0156 | -39 | 0.0002 | -88 | 13.56 | 3 |
| | Equip-Removed[c] | --[d] | --[d] | 8.3975 | 27,614 | 0.5731 | 114,520 | --[d] | --[d] | 3.0056 | 11,687 | 0.0685 | 3,929 | 14.60 | 11 |
| SCT | Baseline | 1.036 | -- | 0.0303 | -- | 0.0005 | -- | 5.384 | -- | 0.0255 | -- | 0.0017 | -- | 13.16 | -- |
| | Equip-Present[b] | 0.911 | -12 | 0.0146 | -52 | 0.0005 | 0 | 6.111 | 14 | 0.0146 | -43 | 0.0013 | -24 | 13.58 | 3 |
| | Equip-Removed[c] | --[d] | --[d] | 1.3222 | 4,264 | 0.4524 | 90,380 | --[d] | --[d] | 4.8951 | 19,096 | 0.2103 | 12,271 | 14.04 | 7 |

SO – System Out (tailpipe)
Red – Large increase from baseline
Yellow – Potential increase from baseline
a – Percent difference of the result compared to baseline (or stock OEM). Negative values represent decreases. Positive values represent increases.
b –Emissions equipment-present calibration
c –Emissions equipment-removed calibration
d – No EO data was available when emission equipment was removed.

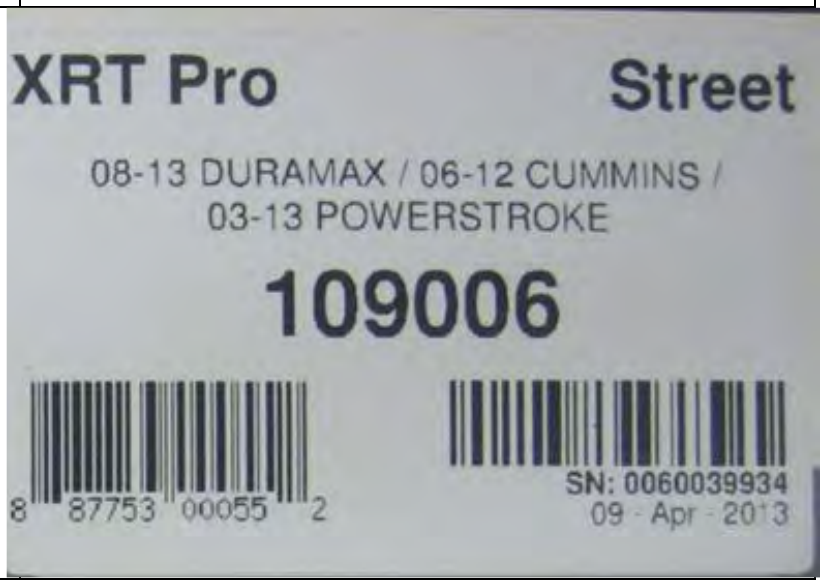
# APPENDIX A
# PHOTOGRAPH LOG

| **PHOTOGRAPH #:** 1 | |
|---|---|
| **TAKEN BY:** A. Stanard | **SITE LOCATION:** ERG Austin, Texas Office |
| **DATE TAKEN:** 9/19/2013 | |
| **COMMENTS:** Spartan Phalanx tuner box as received from Rudy's Diesel. |   |

| **PHOTOGRAPH #:** 2 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Front of the Spartan Phalanx box showing several disclaimers. |   |

| **PHOTOGRAPH #:** 3 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** ERG Office, Chantilly Office |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Label observed on the Spartan Phalanx box exterior showing the unit serial number. |  |

| **PHOTOGRAPH #:** 4 | |
|---|---|
| **TAKEN BY:** A. Stanard | **SITE LOCATION:** ERG Austin, Texas Office |
| **DATE TAKEN:** 7/31/2013 | |
| **COMMENTS:** H&S XRT Pro tuner box. |  |

| **PHOTOGRAPH #:** 5 | |
|---|---|
| **TAKEN BY:** A. Stanard | **SITE LOCATION:** ERG Austin, Texas Office |
| **DATE TAKEN:** 7/31/2013 | |
| **COMMENTS:** Label observed on the H&S XRT Pro box exterior showing the unit serial number. |  |

| **PHOTOGRAPH #:** 6 | |
|---|---|
| **TAKEN BY:** A. Stanard | **SITE LOCATION:** ERG Austin, Texas Office |
| **DATE TAKEN:** 7/31/2013 | |
| **COMMENTS:** Top half of the warranty card found inside the H&S XRT Pro box containing the part number and serial number for the unit. | **OFF-ROAD / RACE UPGRADE INSTRUCTIONS**<br>Part Number: 6009 \| Serial Number: 0060039934 \| Upgrade NUMBER: 35089<br>POWER UP THE DOWNLOADER BY PLUGGING IT INTO THE TRUCKS OBD2 PORT<br>SELECT ANY VEHICLE APPLICATION<br>THE DOWNLOADER WILL OPEN UP THE MAIN MENU<br>THEN GO TO: USER OPTIONS>EMISSIONS SELECTION<br>(THEN ENTER THE UPGRADE NUMBER)<br>ONCE THE DOWNLOADER IS UPGRADED IT WILL ALWAYS BE UPGRADED<br>IT CAN BE LOCKED & UNLOCKED TO ANY APPLICABLE VECHICLES<br>THIS UPGRADE INCLUDES ALL THE CURRENT UNLOCK CODES<br>DODGE 2006 2012 - FORD 2003 2013 - GM 2008 2013<br>NEVER TELL H&S THE OFF-ROAD / RACE UPGRADE IS INSTALLED<br>DOING SO MAY VOID THE WARRANTY<br>NEVER CONTACT H&S WITH ANY OFF-ROAD / RACE UPGRADE<br>RELATED QUESTIONS OR ISSUES – CONTACT YOUR DEALER<br>FOR ADDITIONAL H&S DOWNLOADS IT IS RECOMMENDED<br>TO CONTACT YOUR DEALER |

| **PHOTOGRAPH #:** 7 | |
|---|---|
| **TAKEN BY:** A. Stanard | **SITE LOCATION:** ERG Austin, Texas Office |
| **DATE TAKEN:** 7/31/2013 | |
| **COMMENTS:** Bottom half of the warranty card found inside the H&S XRT Pro box. | **IMPORTANT WARRANTY INFORMATION**<br>NEVER TELL H&S THE OFF-ROAD / RACE UPGRADE IS INSTALLED<br>DOING SO MAY VOID THE WARRANTY<br>BEFORE INSTALLING THE DOWNLOADER OFF-ROAD / RACE UPGRADE<br>REGISTER THE DOWNLOADER AT: WWW.HSPERFORMANCE.COM/REGISTER<br>**PRODUCT REGISTRATION INSTRUCTIONS**<br>ENTER ALL OF THE OWNER INFORMATION<br>PRODUCT INFORMATION SECTION<br>ENTER TUNER MODEL XRT PRO STREET<br>ENTER TUNER SERIAL NUMBER ON THE WARRANTY CARD<br>ENTER WHERE WAS THE TUNER PURCHASED YOUR DEALER NAME<br>ENTER YOUR PURCHASE PRICE $$$$$$<br>ENTER ALL REQUESTED DATE INFORMATION AND SUBMIT<br>**ALWAYS INSTALL THE TUNER BEFORE MAKING ANY OFF-ROAD / RACE MODIFICATIONS**<br>ONCE THE TUNER AND TRUCK ARE FUNCTIONING CORRECTLY YOU CAN PROCEED WITH YOUR OFF-ROAD / RACE MODIFICATIONS |

| **PHOTOGRAPH #:** 8 | |
|---|---|
| **TAKEN BY:** A. Stanard | **SITE LOCATION:** ERG Austin, Texas Office |
| **DATE TAKEN:** 9/23/2013 | |
| **COMMENTS:** SCT 3015R tuner package as received from Rudy's Diesel. |  |

| **PHOTOGRAPH #:** 9 | |
|---|---|
| **TAKEN BY:** A. Stanard | **SITE LOCATION:** ERG Austin, Texas Office |
| **DATE TAKEN:** 9/23/2013 | |
| **COMMENTS:** SCT 3015R tuner package as received from Rudy's Diesel. |   |

| **PHOTOGRAPH #:** 10 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** ERG Chantilly, Virginia Office |
| **DATE TAKEN:** 2/6/2014 | |
| **COMMENTS:** SCT 3015R Tuner serial number observed on back of tuner. |   |

| **PHOTOGRAPH #:** 11 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Flo-Pro aftertreatment delete kit as received from USA Performance. |   |

| **PHOTOGRAPH #:** 12 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Label on the Flo-Pro aftertreatment delete kit received from USA Performance indicating that the aftertreatment delete pipe received is for the 6.4 Liter Powerstroke, not the 6.7 Liter. |   |

| **PHOTOGRAPH #:** 13 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Flo-Pro aftertreatment delete kit as received from Wolf Diesel Performance. |  |

| **PHOTOGRAPH #:** 14 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Flo-Pro aftertreatment delete kit out of the box. |  |

| **PHOTOGRAPH #:** 15 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Label observed on the Flo-Pro box exterior showing Wolf Diesel Performance and the original supplier, Thunder Diesel, located in Mountain Home, Arkansas. |  |

| **PHOTOGRAPH #:** 16 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Overview of the test vehicle on the dynamometer. |  |

| **PHOTOGRAPH #:** 17 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Close up of the vehicle chassis model (i.e., Ford-350). |  |

| **PHOTOGRAPH #:** | 18 |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Vehicle emission control information (VECI) label on test vehicle. |  |

| **PHOTOGRAPH #:** 19 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Odometer reading prior to any testing. 33,932.6 miles. Note: Ford stated that the actually vehicle had approximately 34,000 miles but the aftertreatment system had only been used for 4,000 miles prior to testing. Ford installed a new aftertreatment system prior to testing. |  |

| **PHOTOGRAPH #:** 20 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** OEM after treatment system. The system includes three catalysts: OC (left), SCR (middle), and DPF (right). |  |

| **PHOTOGRAPH #:** 21 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Label on the vehicle chassis. |  |



| **PHOTOGRAPH #:** | 22 |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** VIN of test vehicle visible through the bottom of the front windshield. |  |

| **PHOTOGRAPH #:** 23 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/3/2013 | |
| **COMMENTS:** Screen shot of the Spartan 6.7 Liter Phalanx turning on. |  |

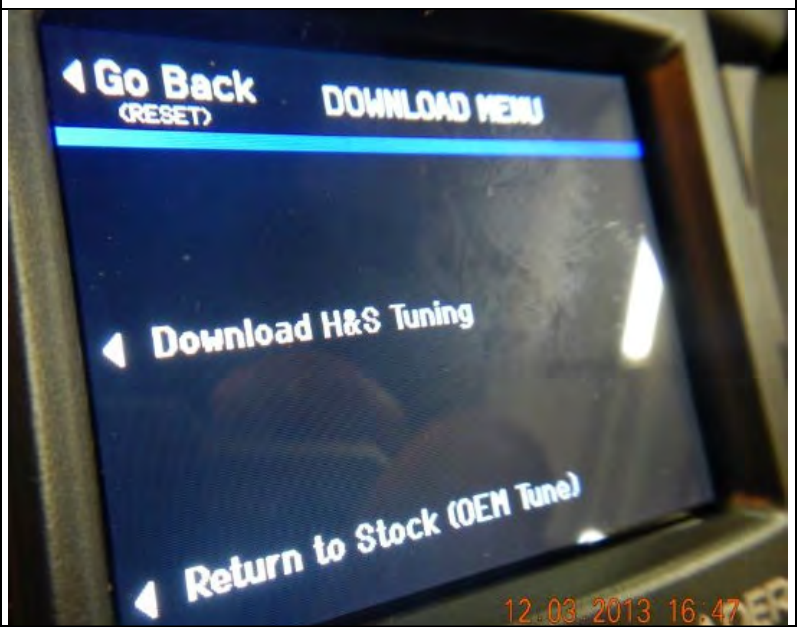
| **PHOTOGRAPH #:** 24 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Screen shot of Spartan 6.7 Liter Phalanx showing "off-road" disclaimer that appears immediately after turning on the device. |  |

| **PHOTOGRAPH #:** 25 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Main menu options on the Spartan 6.7 Liter Phalanx. |  |

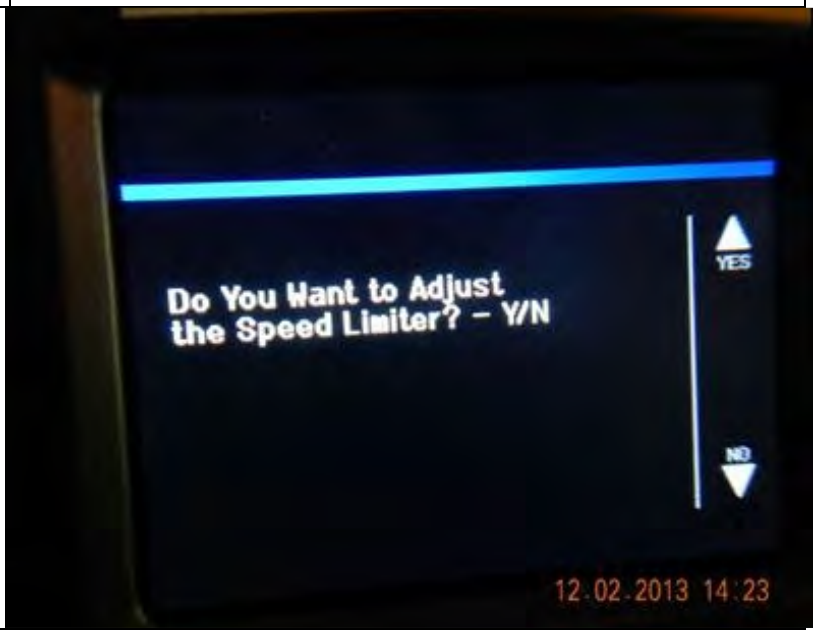
| **PHOTOGRAPH #:** 26 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the Spartan 6.7 Liter Phalanx showing the calibration selected for emission equipment-present testing. |  |

| **PHOTOGRAPH #:** 27 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Screen shot of the Spartan 6.7 Liter Phalanx showing the calibration selected for emission equipment-removed testing.<br><br>ERG installed this calibration on 4 December 2013, the day prior to testing. It was installed immediately before Ford installed the Flo-Pro aftertreatment delete kit on 4 December 2013. |  |

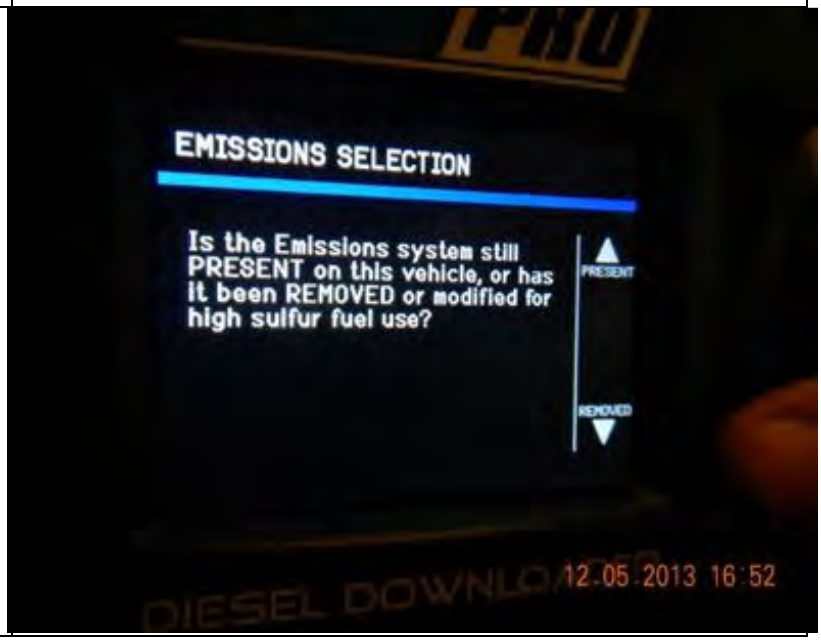
| **PHOTOGRAPH #:** 28 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of available vehicle options (partial list) that the H&S XRT Pro can be used for. The tuner contains preloaded tunes for each of these vehicles. |  |

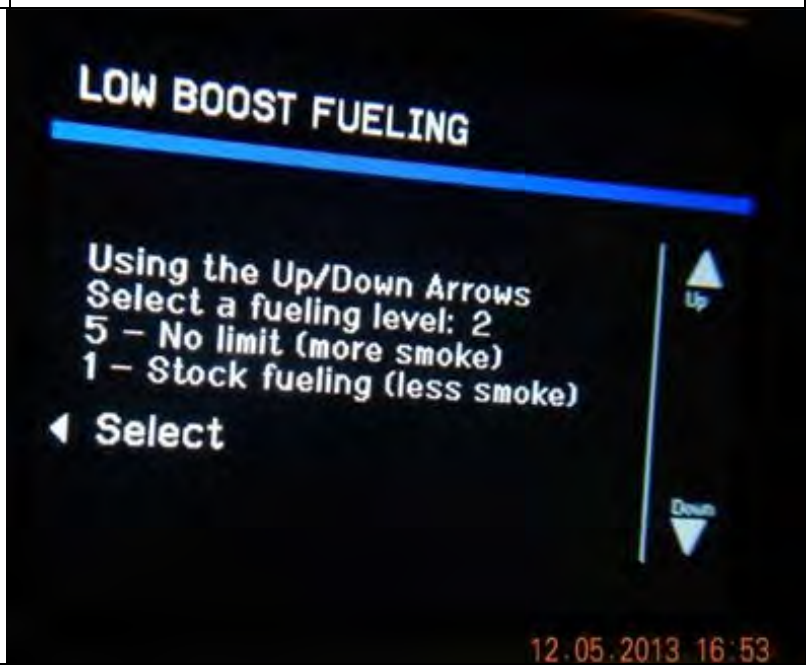
| **PHOTOGRAPH #:** 29 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Download menu shown on the H&S XRT Pro. This menu option is used to install a new H&S calibration or return the ECM to the stock calibration. |  |

| **PHOTOGRAPH #:** 30 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the H&S XRT Pro showing the calibration selected for emission equipment-present testing (Performance). |  |

| **PHOTOGRAPH #:** 31 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the H&S XRT Pro showing the installation option to adjust the vehicle speed limiter. ERG always selected "no" for this option. |   |

| **PHOTOGRAPH #:** 32 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the H&S XRT Pro showing the installation option to tune the transmission. ERG always selected "no" for this option. |   |

| **PHOTOGRAPH #:** 33 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/5/2013 | |
| **COMMENTS:** Screen shot of the H&S XRT Pro showing the prompt for indicating whether the emission equipment has been removed from the vehicle. This option only appeared after the "upgrade code" for "high sulfur" fuel use was entered as shown in Photograph [35]. ERG selected "removed" for emissions equipment-removed testing. |  |

| **PHOTOGRAPH #:** 34 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford testing facility |
| **DATE TAKEN:** 12/5/2013 | |
| **COMMENTS:** Screen shot of the H&S XRT Pro showing option for adjusting the low boost fueling. ERG chose option number 5 (i.e., no low boost fueling limit). This option only appeared after the "upgrade code" was entered for "high sulfur" fuel use as shown in Photograph [35]. This option is only available when the user selects that the emissions equipment has been removed. |  |

| **PHOTOGRAPH #:** 35 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/3/2013 | |
| **COMMENTS:** Screen shot of the H&S XRT Pro showing the "upgrade code" for "high sulfur" fuel use entered into the emissions selection menu. After entering this code, the user is given the option to enter whether or not the emissions control systems (i.e., DPF and EGR) are present during the installation process (Photographs [34] and [35]). |  |

| **PHOTOGRAPH #:** 36 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/3/2013 | |
| **COMMENTS:** Screen shot of the H&S XRT Pro immediately after the "high sulfur" "upgrade code" was entered shown in Photograph 35. |  |

| **PHOTOGRAPH #:** 37 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/5/2013 | |
| **COMMENTS:** First EGR valve electrical connection disconnected prior to conducting emission equipment-removed testing for the H&S XRT Pro. |  |

| **PHOTOGRAPH #:** 38 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/5/2013 | |
| **COMMENTS:** Second EGR valve electrical connection disconnected prior to conducting emission equipment-removed testing for the H&S XRT Pro. Note: Photograph was taken prior to disconnection because the Ford Technician had to obtain a long screw driver to remove this connection due to the lack of space. This sensor is directly behind the cooling fan (shown in left side of photo) in the front of the engine compartment. |  |

| **PHOTOGRAPH #:** 39 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner showing the "strategy tune" menu option selected to install new calibrations. |   |

| **PHOTOGRAPH #:** 40 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner during the initial installation process for the emissions equipment-present calibration. The SCT recognized the 6.7 Liter Powerstroke engine but, as shown in Photograph [41], required an update in order to install calibrations. |   |

| **PHOTOGRAPH #:** 41 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner during the initial installation process for the emissions equipment-present calibration. The SCT 3015R tuner was unable to install any calibrations prior to the software update, as indicated in this Photograph. |  |

| **PHOTOGRAPH #:** 42 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner during the installation process prompting the user to indicate if the aftertreatment system has been removed. ERG selected “yes” for emission equipment-removed testing and “no” for emissions equipment-present testing. |  |

| **PHOTOGRAPH #:** 43 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner during the installation process prompting the user to indicate recalibration of the speedometer for non-stock tires is desired. ERG always selected "no" for this option. |  |

| **PHOTOGRAPH #:** 44 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner during the installation process prompting the user to indicate if any non-stock gears have been installed. ERG always selected "no" for this option. |  |

| **PHOTOGRAPH #:** 45 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner during the installation process prompting the user to indicate if changing the tire pressure monitoring system is desired. ERG always selected "no" for this option. |  |

| **PHOTOGRAPH #:** 46 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner during the installation process prompting the user to select a calibration. ERG selected "performance" both emission equipment-removed and – present testing. |  |

| **PHOTOGRAPH #:** 47 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner during the installation process prompting the user to adjust the speed limiter. ERG always selected "no" for emission equipment-present testing and "yes" for emission equipment-removed testing. |   |

| **PHOTOGRAPH #:** 48 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/2/2013 | |
| **COMMENTS:** Screen shot of the SCT 3015R tuner during the installation process prompting the user to if tuning the transmission is desired. ERG always selected "stock" for this option. |   |

| **PHOTOGRAPH #:** 49 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Flo-Pro aftertreatment delete pipe installed onto the test vehicle. |  |

| **PHOTOGRAPH #:** 50 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Black smoke generated by test vehicle after installing the Flo-Pro aftertreatment delete kit and an emission equipment-removed calibration using the Spartan 6.7 Liter Phalanx tuner. |  |

| **PHOTOGRAPH #:** 51 | |
|---|---|
| **TAKEN BY:** B. Ruminski | **SITE LOCATION:** Ford Testing Facility |
| **DATE TAKEN:** 12/4/2013 | |
| **COMMENTS:** Black smoke generated by test vehicle after installing the Flo-Pro aftertreatment delete kit and an emission equipment-removed calibration using the Spartan 6.7 Liter Phalanx tuner. |   |

## APPENDIX B
## CHRONOLOGICAL ORDER OF PRODUCED PERFORMED BY FORD, EPA, AND ERG

## Table 18. Chronological Order of Procedures Performed by Ford, EPA, and ERG The Week of 2 December 2013

| Day | Tuner | Step |
|---|---|---|
| 2 December 2014 | Spartan | Obtained OBD data (e.g., Cal ID, CVN) with the ECM in the stock configuration |
| | | Installed emissions equipment-present calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| | | Tested vehicle with the FTP4-74 test (with data logger plugged in) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| | | Returned ECM to stock calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) with the ECM in the stock configuration |
| | | Uninstalled designated ECM from test vehicle |
| | XRT | Installed designated ECM into test vehicle and reset anti-theft system |
| | | Obtained OBD data (e.g., Cal ID, CVN) with the ECM in the stock configuration |
| | | Installed emissions equipment-present calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| | | Tested vehicle with the FTP4-74 test (with data logger plugged in) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| | | Returned ECM to stock calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) from the ECM in the stock configuration |
| | | Uninstalled designated ECM from test vehicle |
| | SCT | Installed designated ECM into test vehicle and reset anti-theft system |
| | | Obtained OBD data (e.g., Cal ID, CVN) with the ECM in the stock configuration |
| | | Installed emissions equipment-present calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| 3 December 2014 | SCT | Tested vehicle with the FTP4-74 test (with data logger plugged in) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| | | Tested vehicle with the US06 test (with data logger plugged in) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| | | Returned ECM to stock calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) from the ECM in the stock configuration |
| | | Uninstalled designated ECM from test vehicle |
| | Spartan | Installed designated ECM into test vehicle and reset anti-theft system |
| | | Obtained OBD data (e.g., Cal ID, CVN) with the ECM in the stock configuration |
| | | Installed emissions equipment-present calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| 4 December 2014 | Spartan | Tested vehicle with the US06 test (with data logger plugged in) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| | | Returned ECM to stock calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) from the ECM in the stock configuration |
| | | Installed emissions equipment-removed calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-removed calibration installed |
| | | Removed stock aftertreatment (DOC, DPF) systems and installed aftertreatment delete kit |
| | | Performed transmission relearn |

**Table 18. Chronological Order of Procedures Performed by Ford, EPA, and ERG The Week of 2 December 2013**

| Day | Tuner | Step |
|---|---|---|
| 5 December 2014 | Spartan | Tested vehicle with the FTP4-74 test (with data logger plugged in) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-removed calibration installed |
| | | Returned ECM to stock calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) from the ECM in the stock configuration |
| | | Uninstalled designated ECM from test vehicle |
| | SCT | Installed designated ECM into test vehicle and reset anti-theft system |
| | | Obtained OBD data (e.g., Cal ID, CVN) with the ECM in the stock configuration |
| | | Installed emissions equipment-removed calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-removed calibration installed |
| | | Tested vehicle with the FTP4-74 test (with data logger plugged in) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-removed calibration installed |
| | | Returned ECM to stock calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) from the ECM in the stock configuration |
| | | Uninstalled designated ECM from test vehicle |
| | XRT | Installed designated ECM into test vehicle and reset anti-theft system |
| | | Obtained OBD data (e.g., Cal ID, CVN) with the ECM in the stock configuration |
| | | Installed emissions equipment-removed calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-removed calibration installed |
| 6 December 2014 | XRT | Tested vehicle with the FTP4-74 test (with data logger plugged in) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-removed calibration installed |
| | | Returned ECM to stock calibration |
| | | Obtained OBD data (e.g., Cal ID, CVN) from the ECM in the stock configuration |
| | | Installed emissions equipment-present calibration (calibration analyzed by Bosch) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |
| | | Uninstalled designated ECM from test vehicle |
| | Spartan | Installed designated ECM into test vehicle and reset anti-theft system |
| | | Obtained OBD data (e.g., Cal ID, CVN) with the ECM in the stock configuration |
| | | Installed emissions equipment-present calibration (calibration analyzed by Bosch) |
| | | Obtained OBD data (e.g., Cal ID, CVN) with equipment-present calibration installed |

Note: The first test run on each day was a cold start test because the engine did not run since the previous test the day before. Any 2nd or 3rd tests performed on a particular day were warm or hot starts. However, because each test includes multiple test cycles and this report only compares the test results of the last test cycle in each test, it is irrelevant whether the test was a cold, warm, or hot start because the engine was always hot for the last test cycle. See Section IV.B.5 for more detail.

## APPENDIX C
## SPARTAN TUNER PURCHASE MEMORANDUM

ERG

**MEMORANDUM**

**TO:** Anne Wick, US EPA

**FROM:** Alan Stanard, ERG

**SUBJECT:** Summary of purchase of Spartan Phalanx Tuner

**DATE:** September 30, 2013

## Research, Communication and Purchase of Spartan Tuner

Under Contract #EP-W-12-007 Technical Direction 45, EPA directed ERG to research and purchase a Spartan Phalanx Diesel Tuner that was advertised as having exhaust gas recirculation EGR /diesel particulate filter DPF delete features. ERG identified three companies that indicated they sold the Phalanx Tuner on their websites: Rudy's Diesel Performance www.rudysdiesel.com), Xtreme Diesel Power http://www.xtremediesel.com), and Performance Truck Products performancetruckproducts.com). EPA indicated that ERG should choose a Phalanx Tuner that would work with a MY 2011- MY 2014 Ford F-250 or F-350 with a 6.7 L engine. The websites of all three retailers offered the Phalanx for the 6.7 L Ford at prices within two percent of each other.

### Communication with Supplier

EPA directed ERG that Rudy's Diesel was the preferred vendor for this unit. ERG called Rudy's and asked the sales representative a few questions about the tuner and the purchase process. The representative indicated that the device could allow an EGR/DPF delete. A VIN would not be needed at the time of purchase, but the tuner would permanently associate with the truck it was first installed on. In order to install the unit on another truck, the user would need to purchase another license from Spartan Tuners.

### Purchase of Tuner

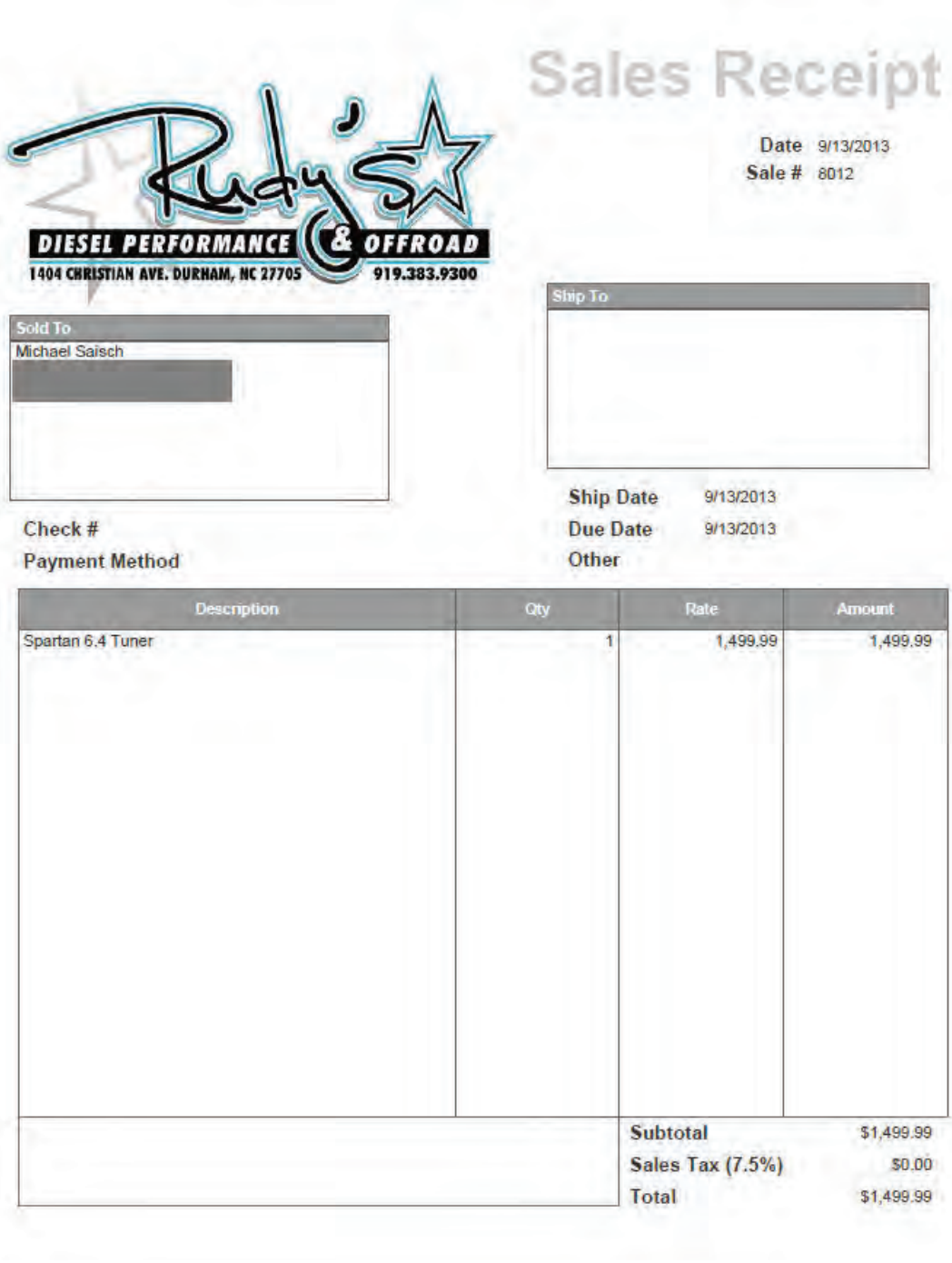
Figure 1 shows the page for the Phalanx Tuner on the Rudy's Website. Note that there are five pull-down menus that include optional extras to be purchased with the tuner. The last two options for EGR Cooler Delete/EGT Probe Mount and Mounting Solution cannot be declined by the user as a result of the way the menus are designed.

Figure 2 shows the screen capture displayed after selecting to buy the Spartan Tuner and includes the two forced optional extras (EGR Cooler Delete and EGT Probe Mount). ERG did not want to incur the extra expense of these devices give that they may not be beneficial to EPA, and so chose to order the tuner via telephone. Via the telephone, the sales representative did not require the purchase of the optional extras. ERG ordered the tuner on September 13, 2013.

The total purchase price without the optional extras was $1,499.99. The sales receipt was received promptly from Rudy's Performance and is presented in Figure 3. Note that there was some confusion on the part of the sales representative on whether the tuner was for the 6.7 L Ford or the 6.4 L Ford. ERG clearly indicated that the desired tuner was for the 6.7 L vehicle, but the sales receipt still indicated that the tuner would be for the 6.4 L vehicle. Upon receipt, ERG confirmed the tuner that was received was for the 6.7 L vehicle.


**Figure 1. Screen Capture of the Spartan Phalanx Offered for Sale on the Rudy's Website**


**Figure 2. Screen Capture from the Rudy's Website after Adding the Spartan Phalanx to Cart**



Rudy's DIESEL PERFORMANCE & OFFROAD
1404 CHRISTIAN AVE. DURHAM, NC 27705 919.383.9300

# Sales Receipt

Date 9/13/2013
Sale # 8012

**Sold To**
Michael Saisch
[redacted]

**Ship To**

Ship Date 9/13/2013
Due Date 9/13/2013
Other

Check #
Payment Method

| Description | Qty | Rate | Amount |
|---|---|---|---|
| Spartan 6.4 Tuner | 1 | 1,499.99 | 1,499.99 |

| | |
|---|---|
| Subtotal | $1,499.99 |
| Sales Tax (7.5%) | $0.00 |
| Total | $1,499.99 |

**Figure 3. Sales Receipt of Spartan Phalanx from Rudy's Performance after Phone Order**

## Receipt of Tuner

ERG received the tuner on September 19, 2013. The hardware for the unit was a Drew Technologies DashDAQ, and the unit arrived in the original DashDAQ box. The contents of the box are shown in Figure 4. The serial number of the unit was 018914130513Q. This appears to be the DashDAQ serial number, not a number given by Spartan. It is unclear what the relationship between Spartan and Drew Technologies is. It is likely that Spartan purchases DashDAQ units either 'blank' or with minimal programming from Drew Technologies and then installs the software and/or programming that performs the diesel tuning function.

The unit that was received was the model that ERG intended to order for the 6.7 L Ford, so the sales receipt contained a typographical error that was probably related to the confusion of the sales representative at the time of the order. The memory card installed in the tuner contained a number of tuning files as well as a brief manual on how to unlock the tuner for a given truck and how to install the tuning files. The documentation indicated that the unit is not fully functional when received by the purchaser. According to the manual, the VIN and owner information must be sent to Spartan for them to allow the user to register/unlock the tuner. This process is not exactly consistent with the discussions that ERG had with the Rudy's representative over the phone. The representative had originally said that the tuner would be mated to the first truck that it was installed in, and made the process of unlocking the tuner and mating to the VIN of the desired truck sound automatic. The manual also mentions that if the purchaser wants to install the tuner on a second truck, another license must be purchased from Spartan before this can be done.


**Figure 4. Contents of the Spartan Tuner Box upon Delivery**

## APPENDIX D
## SCT TUNER PURCHASE MEMORANDUM

ERG

**MEMORANDUM**

**TO:** Anne Wick, US EPA

**FROM:** Alan Stanard, ERG

**SUBJECT:** Summary of purchase of SCT 3015R Tuner

**DATE:** September 30, 2013

## Research, Communication and Purchase of SCT Tuner

Under Contract #EP-W-12-007 Technical Direction 45, EPA directed ERG to research and purchase an SCT 3025 Tuner that was advertised as having exhaust gas recirculation (EGR)/ diesel particulate filter (DPF) delete features for diesel engines. EPA requested that the purchased tuner be designed for late-model diesel-powered Ford F-250 or F-350 trucks. SCT does not manufacture an SCT 3025 tuner that is compatible with the MY 2011 and newer 6.7 L Ford engine, so ERG pursued the tuner programmed for the MY 2008- MY 2010 6.4 L Ford. However, ERG later determined that the received tuner is in fact compatible with MY 2011 and newer 6.7 Liter Ford engine.

### Communication with Supplier

ERG identified two websites of companies that indicated that they sold the SCT Tuners to the U.S. market: Rudy's Diesel (www.rudysdiesel.com) and Performance Diesel (www.perfdiesel.com). ERG called Performance Diesel to inquire about the 3025 Tuner, but the sales representative indicated that they no longer sold the tuner due to the fact that it allowed for DPF/EGR delete. The sales person did not elaborate further after indicating that that DPF/EGR delete feature was the reason they no longer sold the item.

Next, ERG emailed Rudy's Diesel and asked whether the 3025OR X3 that was listed on their website offered the ability to delete DPF, as well as whether a truck VIN would be needed for purchase. The representative responded that the unit did allow DPF delete and that a specific truck VIN was not needed. Appendix A provides documentation of this email communication. ERG did not explicitly ask if the tuner is capable of deleting the EGR via email. ERG later called Rudy's and asked if the tuner is capable of delete the EGR over the phone. A Rudy's Diesel representative confirmed that the tuner is also able to delete the EGR.

### Purchase of Tuner

ERG ordered the 3025OR X3 Tuner from the website on September 16, 2013. Appendix B provides screen captures during the ordering process on the Rudy's website. A series of screen captures from the entire ordering process along with the received sales receipt are included in Appendix A. The total cost of the tuner was $899.

ERG received the SCT unit on September 23, 2013. Figure 1 and Figure 2 show the SCT tuner in its original packaging on the front side and back side, respectively. It is important to note that the unit ERG received was the SCT 3015R tuner as opposed to the 3025OR X3 that ERG ordered. The serial number of the unit was XP06281339A62.

Figure 3 shows the contents of the packaging. In addition to the tuner and wiring, the container also included a quick start guide and a data CD. The data CD contained a program to allow for firmware updates to the tuner. It also included a variety of instruction documents for various hardware installations on the different types of vehicles that the tuner's hardware is also compatible with (i.e., the tuner hardware is available for a variety of vehicles and programmed differently by SCT for each vehicle). The documentation did not contain any reference to unlocking the tuner or any "race mode" or "off-road only" modes of operation. The quick start guide indicates that the tuner does have the capability for DPF delete, but it doesn't mention EGR. The documentation that comes with the unit appears to be general and intended to apply to all gasoline and diesel vehicles for which SCT sells tuners. It does not appear to be specific to the 6.4 L Ford diesel engine. There appear to be no VIN-specific issues indicated in the documentation, and it appears as though the unit will work with any VIN.


**Figure 1. SCT 3015R as Received by ERG (Front)**


**Figure 2. SCT 3015R as Received by ERG (Back)**


**Figure 3. Contents of SCT 3015R Package as Received by ERG**

# Appendix A

## Communication with Rudy's Deisel

Gmail

Alan S <alans.austin@gmail.com>

**SCT 3025 OR on Website**

2 messages

[redacted] Thu, Sep 12, 2013 at 1:28 PM

To: aaron@rudysdiesel.com

Hi, I had a question about the SCR 3025OR on your website. Does the OR version of this offer the DPF delete option? If so, would the VIN of the truck it would be installed in be required for purchase? (I won't have access to the VIN for a week or so).

Thanks,

[redacted]

**Aaron Rudolf** <rudysperformanceparts@yahoo.com> Thu, Sep 12, 2013 at 1:46 PM

Reply-To: Aaron Rudolf <rudysperformanceparts@yahoo.com>

To: [redacted]

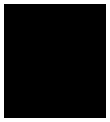
Yes it offers the DPF Delete function. No we do not need the VIN of the truck. Thanks -Aaron

**Aaron @ Rudy's Diesel Performance**
**Shop:** (919) 383-9300
**Toll-Free:** (866) 757-6537
**Fax:** (919) 354-3902
Rudy's Diesel Performance
1404 Christian Ave.
Durham, NC 27705

**From:** [redacted]
**To:** aaron@rudysdiesel.com
**Sent:** Thursday, September 12, 2013 2:28 PM
**Subject:** SCT 3025 OR on Website
[Quoted text hidden]

## Appendix B

## Screen Captures of Online Purchase from Rudysperformance.com



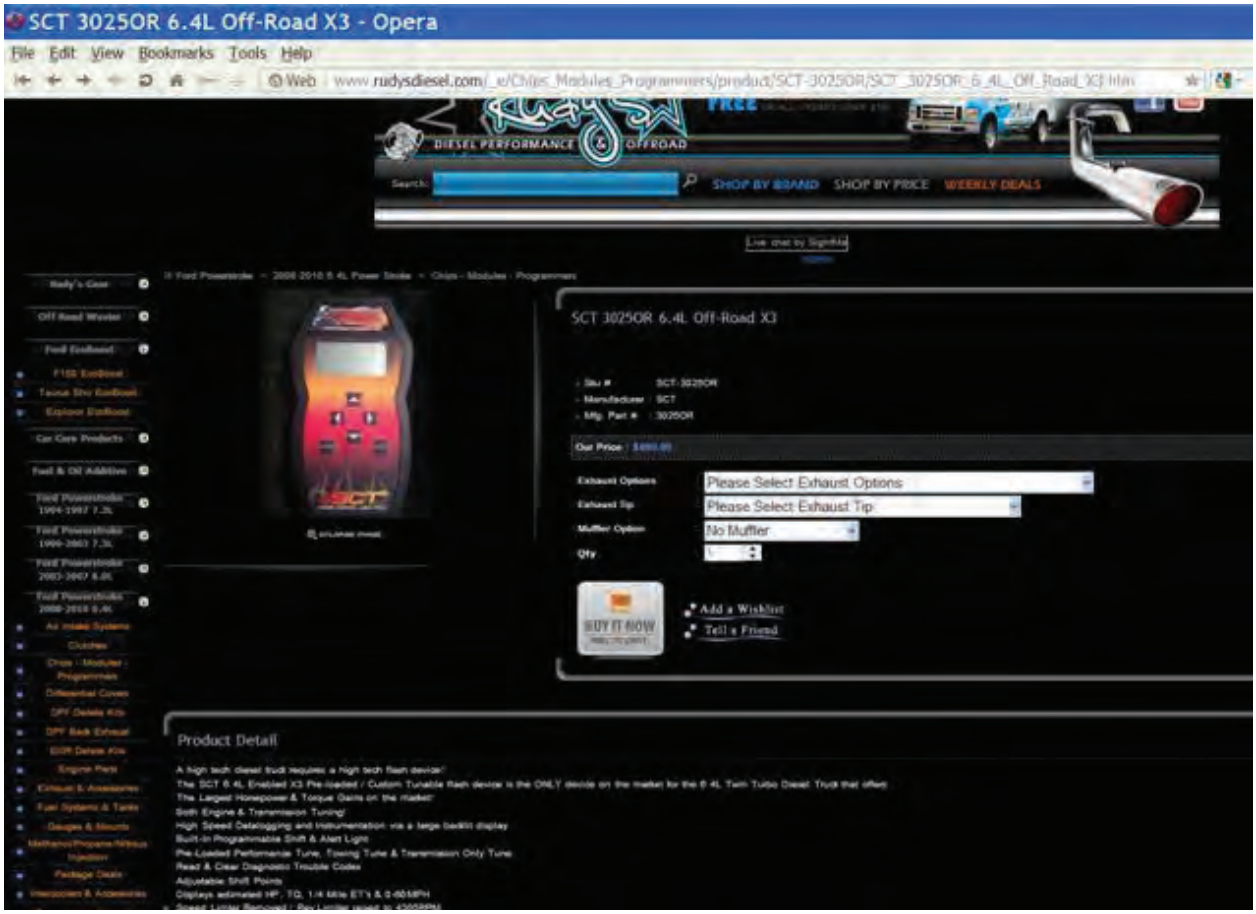



**Figure B-1. SCT 3025OR Tuner for 6.4L Ford as listed on Rudy's Website**

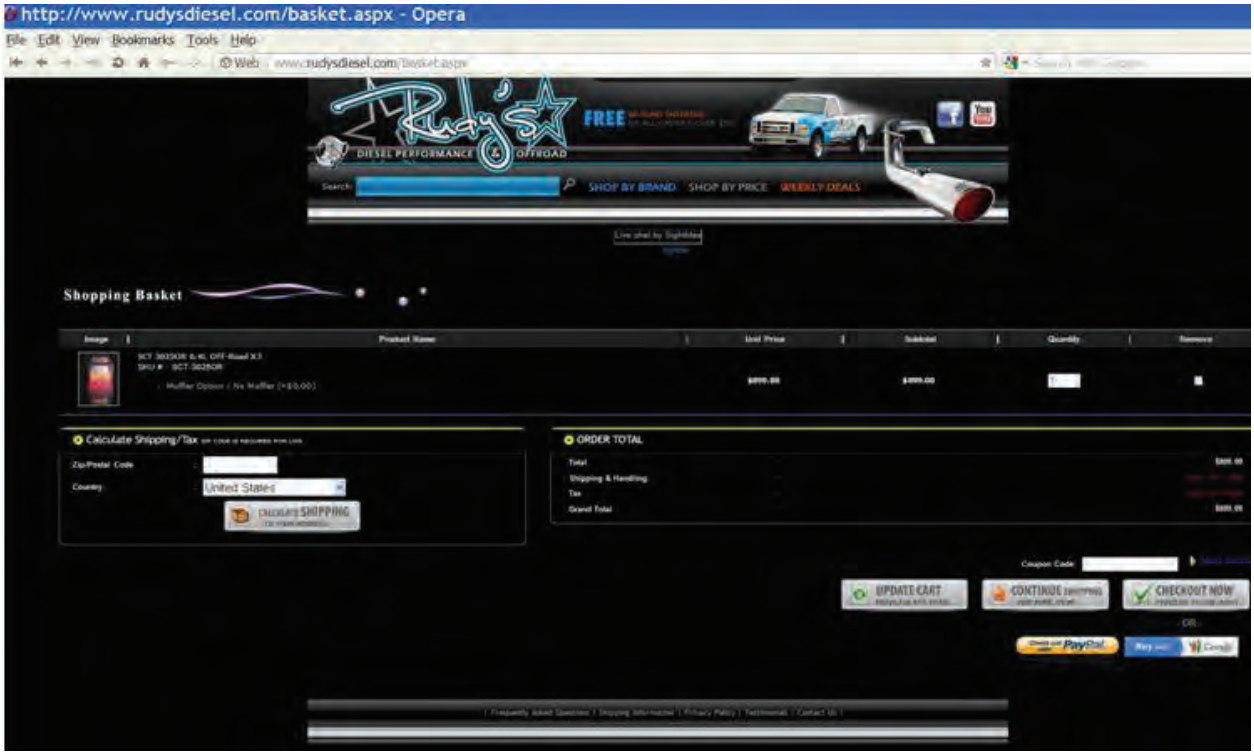



**Figure B-2. SCT 3025OR Tuner in Checkout Basket of Rudy's Website**

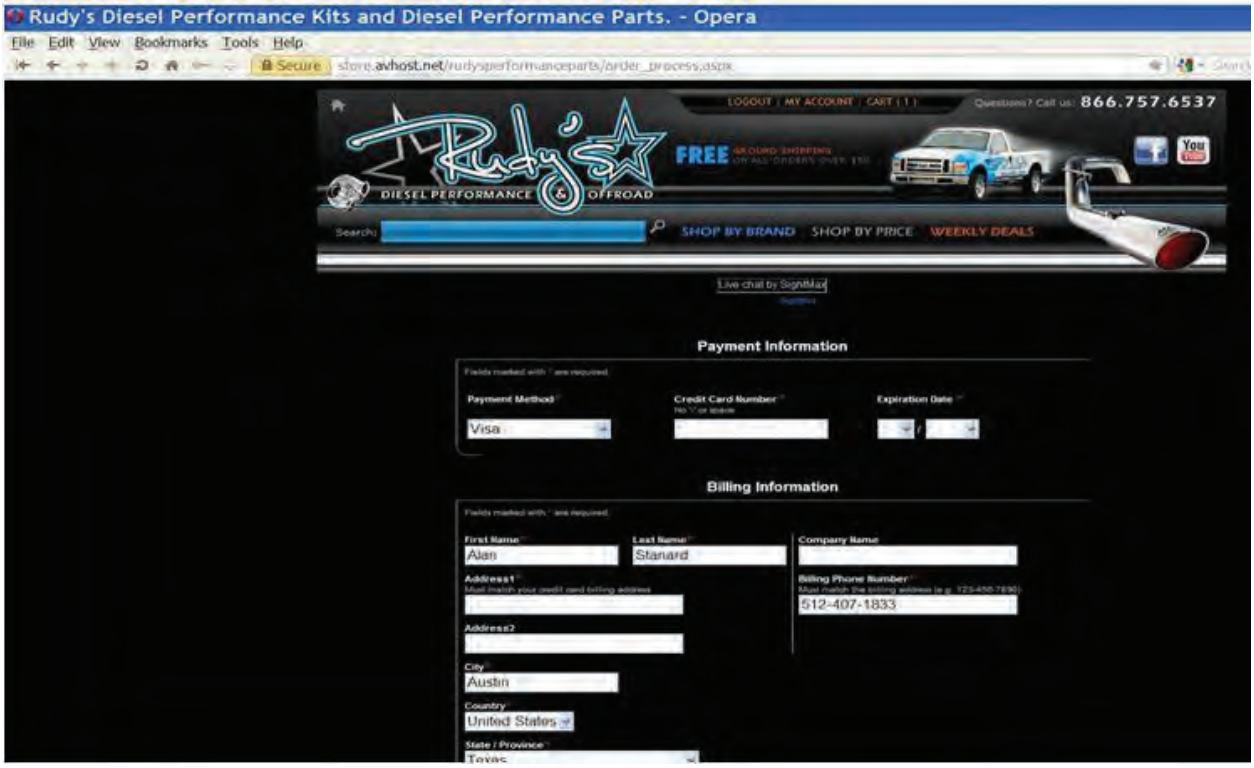



**Figure B-3. Rudy's Website for Entering Payment and Shipping Information**

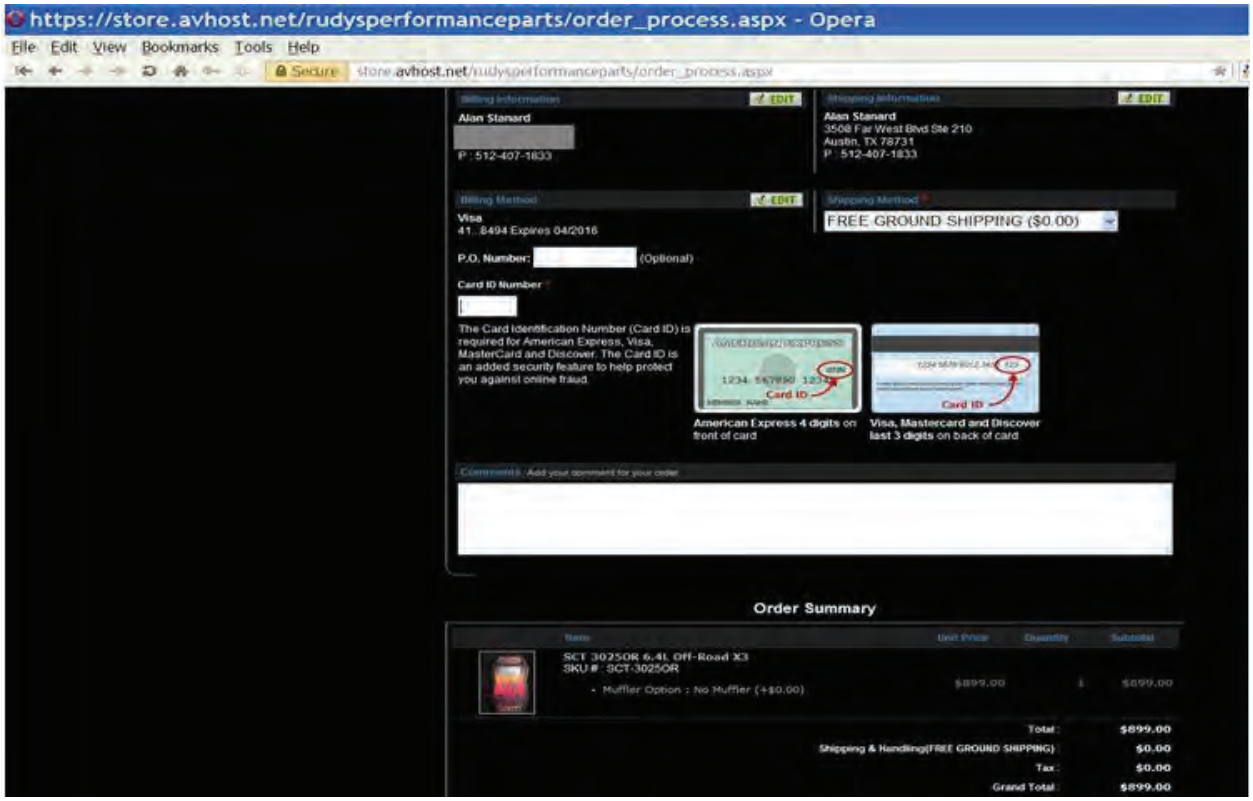



**Figure B-4. Final Summary on Rudy's Website for Checkout (1/2)**

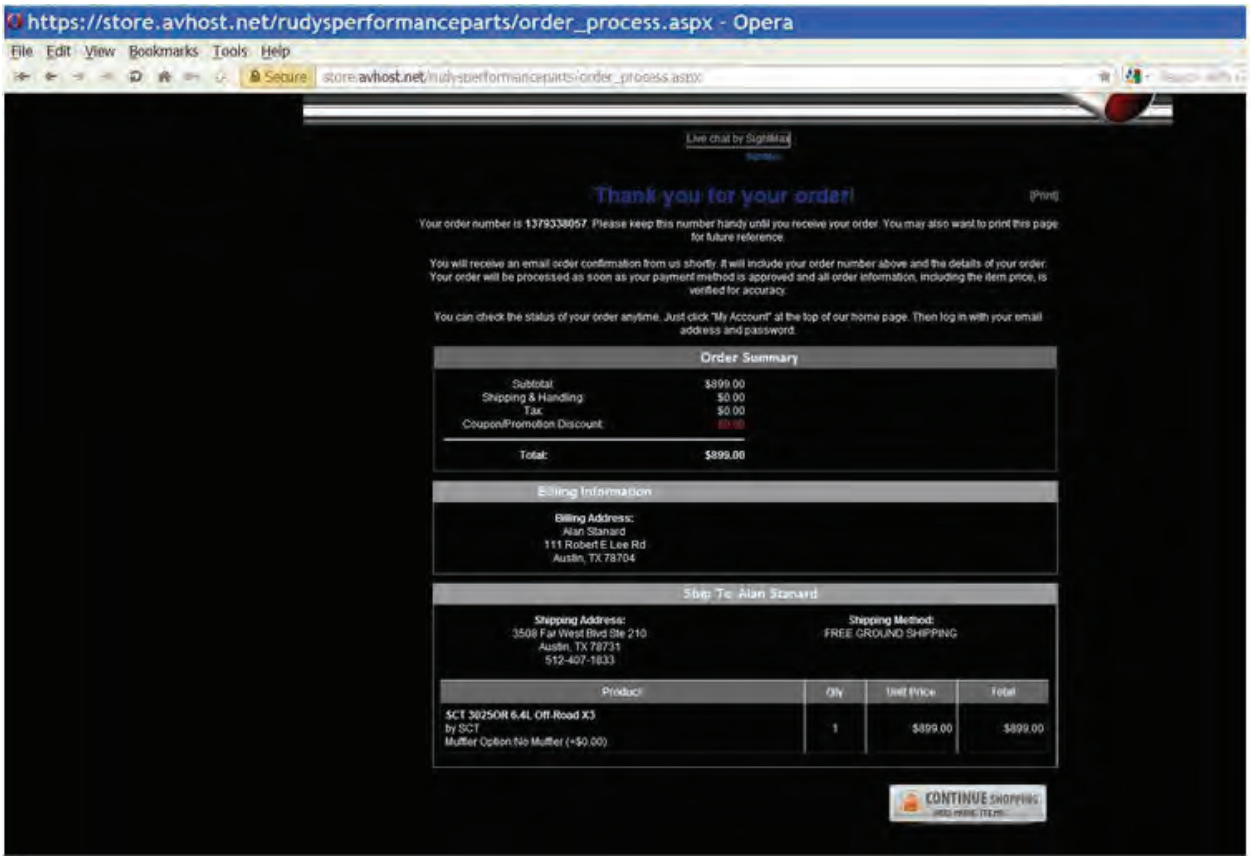



**Figure B-5. Final Summary on Rudy's Website for Checkout (2/2)**

**Order Confirmation(#1379338057)**
1 message

**www.RudysDiesel.com** <order@rudysdiesel.com> Mon, Sep 16, 2013 at 3:27 PM
To: [redacted]

Thank you Alan for shopping at RudyDiesel.com!

Please see your order number and details below. Once your order is shipped, you will receive an email confirmation with the tracking number.

If we may be of further assistance, please call us at 1.866-757-6537 or email us at support@RudysDiesel.com

Sincerely,
Rudys Diesel

Your order number is 1379338057
Order Date: 09/16/2013

Shipping Address:
3508 Far West Blvd Ste 210
Austin, TX 78731

| | |
|---|---|
| Order No. | 1379338057 |
| Date | 09/16/2013 |
| P.O. # | |

**Bill To:**
Alan Stanard
[redacted]
US
512-407-1833

**Ship To:**
Alan Stanard
[redacted]
US
512-407-1833

| Ship Via | Terms | Salesperson |
|---|---|---|
| FREE GROUND SHIPPING | Visa | |
| **Warehouse** | **Credit Card** | **Email Address** |
| | 8494 | alans.austin@gmail.com |

| SKU | Item Description | Unit Price | Qty | Extended |
|---|---|---|---|---|
| SCT-3025OR | SCT 3025OR 6.4L Off-Road X3<br>Muffler Option:No Muffler (+$0.00) | $899.00 | 1 | $899.00 |

| | |
|---|---|
| Subtotal | $899.00 |
| Tax | $0.00 |

**Figure B-6. Page 1 of Receipt from Rudy's for Purchase of SCT Tuner**

| | |
|---|---|
| Shipping & Handling | $0.00 |
| | |
| Total | $899.00 |

SCT-3025OR : SCT 3025OR 6.4L Off-Road X3

**Figure B-7. Page 2 of Receipt from Rudy's for Purchase of SCT Tuner**

## APPENDIX E
## COMMUNICATION WITH SPARTAN FOR TUNER ACTIVATION

## Brent Ruminski - Fwd: 6.7L DashDAQ 18914 Level 1 License Mike Sabisch

**From:** [redacted]
**To:** [redacted]
**Subject:** Fwd: 6.7L DashDAQ 18914 Level 1 License [redacted]

>>> [redacted] 11/27/2013 12:41 PM >>>

>>> <tech@spartandieseltech.com> 11/27/2013 10:09 AM >>>
Before loading a tune on your truck, be sure to have a battery charger connected to one of your batteries. Just set it on trickle charge.

Also please make sure you have followed the instructions on page 3 of the Strategy Flash Manual 67:

DPF DELETE TUNE FILES MUST BE INSTALLED PRIOR TO INSTALLING DPF DELETE EXHAUST COMPONENTS. FAILURE TO INSTALL NEEDED DPF DELETE TUNING BEFORE REMOVING THESE COMPONENTS CAN LEAVE YOUR VEHICLE STRANDED

Index File:

Download the attached file (indexfile.idx) to your computer, then copy to the tuning files folder on the sd card. Do not change the name of the file. If you do you will NOT be able to load a tune on your truck.

Stock File:

Download the attached file to your computer (ESA_PB_STK_ZIP example name), uncompress and copy to the stock files folder on the sd card. The actual stock file will be a .stk file when copied to the stock files folder on the sd card. Size of the uncompressed file will be 4.25 MB (4,461,388 bytes)

The American service-member wrote a check made payable to the United States of America for the amount of UP TO AND INCLUDING MY LIFE. Thank a Soldier, Airmen, Sailor, Marine or Coast Guardsmen for their sacrifices on your behalf.

Mick @ Spartan

Please reply back to this email if you have additional questions. This way I will have your original email available to view.

# Registration

SPARTAN
DIESEL TECHNOLOGIES
Hendersonville, NC (828) 606-3263
www.SpartanDieselTech.com

## RACE USE DISCLAIMER AND LIABILITY WAIVER

**This product is designed for competition racing use only. Use on State and Federal Highways is a violation of the EPA Clean Air Act**. The Clean Air Act can be found at http://www.epa.gov/air/caa/. This document contains in detail what are considered to be violations of the CAA and corresponding penalties for failure to obey and should be read in full before signing this disclaimer and/or installing this off-road, race use only product. Ensuring that all emissions, noise/sound, and speed/use related laws are followed is the responsibility of the Buyer(s). Installation and use of this product indicates that this disclaimer has been read, acknowledged, and understood fully by both the Buyer(s) and Installer(s).

The Buyer(s) assume all associated risk of the purchase and/or use of this product. "Spartan Diesel Technologies" assumes no responsibility of any personal injury, death, or property damage associated with the use of this competition racing use-only product. The Buyer(s) assume all responsibility of ensuring that all applicable speed and safety restrictions are followed during the use of this product. This includes staying within speed limits of tire rating, engine speed restrictions, and legal competition racing use of the vehicle and associated product. The above is regardless of capabilities enabled by use of any "Spartan Diesel Technologies" product. All local, state, and federal laws and ordinances must be adhered during the use of the product. Determining the nature of these laws and ordinances is the exclusive responsibility of the Buyer(s).

Manufacturer Limited Vehicle Warranties should be referenced before installation and use of this product. "Spartan Diesel Technologies" shall not be held responsible for voidance of any Manufacturer Warranties. The vehicle manufacturer is to be referenced directly by the Buyer(s) to determine what is or is not permissible under the Manufacturer's Limited Warranty. The Buyer(s) assume all possible damages and associated costs in the situation of Manufacturer Warranty voidance.

Installation, service, and use are solely the responsibility of the Buyer(s) and Installer(s) of the given product. "Spartan Diesel Technologies" assumes no liability for personal injury or property damage due to misuse, mis-installation, or improper service of the product. The Buyer(s) and Installer(s) assume all responsibility of ensuring that all proper instructions for installation and use are followed. This product is capable of the following:

I. Making the vehicle incompliant with Local, State and Federal emissions regulations.

II. Making the vehicle capable of generating vehicle speeds unsafe for driving conditions.

III. Making the vehicle capable of generating conditions exceeding safe vehicle speeds based on mechanical condition of the vehicle, such as tire speed ratings.

IV. Making the vehicle capable of exceeding mechanical limits of engine speed, power output, and mechanical stress upon the powertrain, driveline, chassis, and body of the vehicle.

V. Producing power and torque output requiring superior driving skills and techniques in order to be safely applied.

It is the sole responsibility of the Buyer(s) and User(s) of this product to be aware of these additional capabilities and adjust the installation and use of the product accordingly. All other warranties, express or implied, are not applicable for the purchase and use of this product. Failure of the product due to misuse or mis-installation is specifically excluded from the Limited Warranty of this product. "Spartan Diesel Technologies" will not be held liable for indirect, incidental and/or consequential damages caused by the purchase, installation, and/or use of the product.

**Signature of this disclaimer and waiver is necessary in order to receive tunes/calibrations from Spartan Diesel Technologies to enable use of our DPF Delete 6.4 Liter, or 6.7 Liter Ford Products.**

**Signature of this disclaimer and waiver implies that the Buyer(s) and all potential User(s) have read, understood, and accepted the contents and responsibilities of both the said disclaimer and Federal EPA Clean Air Act linked and referenced herein.**

**PRINT NAME OF BUYER** [redacted]

**ADDRESS OF BUYER** [redacted]

**CONTACT TELEPHONE** [redacted]

**CITY, START, ZIP CODE** [redacted]

**EMAIL ADDRESS** [redacted]

**TUNER SERIAL NUMBER**
0189141305130

**SIGNATURE OF BUYER** [redacted]

Home
Tuning Devices
Performance Graphs
Compare Us
Online Catalog
Frequently Asked Questions
Race Use Disclaimer and Liability Waiver
Forums
Contact Us
==========
Authorized Spartan Dealers

Hi, sabischm

Logout

| | |
|---|---|
| Hits: | 0 |
| Online Status: | ONLINE |
| Member Since: | 3 months ago |
| Last Online: | Now |
| Last Updated: | 3 months ago |
| Connections: | - |

Contact Info

[redacted]

| | |
|---|---|
| First Name: | [redacted] |
| Last Name: | [redacted] |
| Address: | [redacted] |
| City, State, ZIP: | [redacted] |
| Phone1: | [redacted] |
| Phone2: | - |
| Tuner Serial: | 18914 |
| Tuner Level: | 1 V2 |
| Tuner Purchased From: | Rudy's |
| Year Model: | 2011 |
| VIN: | 1FT8W3CT6BEA00289 |
| Engine Type: | 6.7L |
| Engine Strategy: | BC3A-14C204-FFA |
| Trans Strategy: | BC3A-14C337-CH |
| 6.4 L Tunes: | - |
| Spartan Disclaimer 10-03-12?: | Yes |
| 6.7 L Tunes: | 25HP w/DPF c/c, 40HP, 200HP, 90HP w/DPF c/c, 80HP, 50HP w/DPF, 120HP, 125HP w/DPF, 165HP |
| Truck Model: | F-350 Pickup |
| Two or Four Wheel drive: | 2WD |
| Trans Type: | Automatic |
| Cab Type: | Crew Cab |
| Bed Length: | Long Bed (8.0) |
| Single Rear or Duallie: | Dual Rear Wheel |
| Traction Control Equipped: | Yes |
| Truck Build Date: | - |
| Gear Ratio: | 3:73 |
| Tire Size: | 245x75x17 |
| Intake/Filter Type: | Stock Box, Stock Filter |
| HP Aftermarket Items: | - |
| Any Additional Details: | - |

User Menu
Logout
My Tunes and Files
My Details
Update Tuner
Spartan Default Configuration Files

Your cart is empty
Show cart

© 2014 Spartan Diesel Technologies

## APPENDIX F
## BOSCH'S EVALUATION OF TUNER CALIBRATION

## Calibration File Compare: Spartan 6.7 Liter Phalanx (Emissions-Equipment Present Calibration)

| Feature | Comments |
|---|---|
| Driver demand | Moved to upper bounds |
| Compentent Protection | Moved T3 limit to 900 degC from 800 degC |
| Disable Codes | Vid block, |
| Max engine speed | Moved from 3800 to 4000 |
| Engine Protect | Moving torque and fuel to max allowed |
| Vehicle speed | Moved to max allowed |
| Main timing | At higher toruqes they advanced timing 5 degrees |
| Fuel (Phymod) | Asking for max quanities at full load |
| Rail pressure | Asking for max rail pressure sooner than we are |
| Smoke limit | Allowing for much richer A/F |

**Labels that changed**

AccPed_trqMode0HRngLSpd_GMAP
AccPed_trqMode0LRng_GMAP
AFS_dmMaxThresMoB1_MAP
AirCtl_mDesBasEOMTrq1_MAP
AirCtl_mDesBasEOMTrq2_MAP
AirCtl_mDesBasEOMTrq4_MAP
atm_t_gas_postturbo_sub_b1
CmpPrt_facTrqCorT3_MAP
CmpPrt_facTrqLim_MAP
CmpPrt_trqCorT3_CUR
CmpPrt_tSetPntT3_MAP
Com_nEngMaxSpd_C
CoVeh_trqLim_CUR
DFC_CtlMsk.DFC_CodVarVIDErrP1635_C
DFC_CtlMsk.DFC_MoCComSPI_C
DFC_CtlMsk.DFC_MoFTrqCmp_C
DFC_CtlMsk.DFC_Tprot_Rttp_Err_C
DFC_DisblMsk.DFC_CodVarVIDErrP1635_C
DFC_DisblMsk.DFC_MoCComSPI_C
DFC_DisblMsk.DFC_MoCSOPErrMMRespByte_C
DFC_DisblMsk.DFC_MoCSOPErrNoChk_C
DFC_DisblMsk.DFC_MoFTrqCmp_C
DFC_DisblMsk.DFC_Tprot_Rttp_Err_C
DFES_Cls.DFC_MoCComSPI_C
DFES_Cls.DFC_MoCROMErrXPg_C
DFES_Cls.DFC_MoCSOPErrMMRespByte_C
DFES_Cls.DFC_MoCSOPErrNoChk_C
DFES_Cls.DFC_Tprot_Rttp_Err_C
EGTCond_nEngMaxCSH_C
EngDa_trqEngMax_C
EngDem_trqLimErr1_CUR
EngDem_trqLimErr2_CUR
EngDem_trqLimErr3_MAP
EngICO_nCtOffCmftICO_C
EngICO_nCtOffCmftICOHard_C
EngICO_nCtOffStdICO_C
EngPrt_qLim_CUR
EngPrt_trqNLim_CUR
EngPrt_trqOvhtPrvNRng_MAP
EngPrt_trqPresCor_MAP
I14229Appl_Std_xCalPartNum_ASC
InjCrv_phiMI1Bas1Cfg1EOM0_MAP
InjCrv_phiMI1Bas1Cfg1EOM3_MAP

**Labels that changed (continued)**

InjCrv_phiMI1Bas1Cfg2EOM0_MAP
InjCrv_phiMI1Bas1Cfg2EOM3_MAP
InjCrv_phiMI1Bas1Cfg3EOM0_MAP
InjCrv_phiMI1Bas1Cfg3EOM3_MAP
LLim_vMaxFix_C
MoCMem_ctDebHealChkRAM_C
MoCMem_ctDebHealChkRAMCpl_C
MoCMem_ctDebHealChkROM_C
MoCMem_ctDebHealChkROMCpl_C
MoCRam_noRAMChkSD_CW
MoCSOP_stCANErrReac_CW
MoCSOP_stMMErrReac_CW
MoFDrDem_rTrqEng_MAP
MoFICO_nCtOff_C
MoFTrqCmp_ctDeb_C
MoFTrqCmp_ctRst_C
MoFTrqIdc_q2trq_MAP
MoFTrqIdc_q2trq2_MAP
PhyMod_qCorBas1EOM0_MAP
PhyMod_qCorBas2EOM0_MAP
PhyMod_trq2qBasEOM0_MAP
PhyMod_trq2qBasEOM1_MAP
PhyMod_trq2qBasEOM2_MAP
PhyMod_trq2qBasEOM3_MAP
PhyMod_trq2qBasEOM4_MAP
PPC_CHIPID
Rail_pSetPointBas1EOM0_MAP
Rail_pSetPointBas1EOM3_MAP
Rail_pSetPointBasEOM0_MAP
Rail_pSetPointBasEOM3_MAP
RngMod_trqSpd_CUR
SmkLim_rLamNrmModDyn_MAP
SmkLim_rLamRgn2ModDyn_MAP
SmkLim_rLamSmkNrmMode_MAP
SmkLim_rLamSmkRgn0_MAP
SmkLim_rLamSmkRgn2_MAP
t3m_t3est_bas_b1_a
t3m_t3est_bas_b2_a
Tra_trqMaxGear1_CUR
Tra_trqMaxGear2_CUR
VehV_vMax_C

## Calibration File Compare: H&S XRT Pro (Emissions-Equipment Present Calibration)

| Feature | Comments |
|---|---|
| Driver demand | Increasing torque very early on in pedal |
| Compentent Protection | Moved T3 way out |
| Disable Codes | |
| Max engine speed | Tried to move to 4500 (Not sure if it will work) |
| Engine Protect | Moved over heat for coolant and oil out of the way |
| Vehicle speed | Moved to max allowed |
| Main timing | Moved 2 degrees at full load |
| ~~Rail pressure~~ | |
| Smoke limit | Allowing richer A/F |
| Lug curve | Moved out of the way |
| Injector energizig (Fuel) | Asking for more fuel through injector energizing time |

**Labels that changed**

AccPed_trqExhBrkDemSet_MAP
AccPed_trqMode0HRngLSpd_GMAP
AFS_trqWinLdAdjThresHiPnt0_CUR
AirCtl_trqLimThresHi_CUR
CmpPrt_tSetPntT3_MAP
Com_nEngMaxSpd_C
DFC_CtlMsk.DFC_MoCROMErrXPg_C
DFC_DisblMsk.DFC_AFSMoTrbMinB1_C
DFC_DisblMsk.DFC_AirTMonPlaus_0_C
DFC_DisblMsk.DFC_AirTMonPlaus_1_C
DFC_DisblMsk.DFC_AirTMonPlaus_2_C
DFC_DisblMsk.DFC_AirTMonPlaus_3_C
DFC_DisblMsk.DFC_AirTMonPlaus_4_C
DFC_DisblMsk.DFC_F2DSM_TrbChActCalcB2_C
DFC_DisblMsk.DFC_I14229KOERWGTstFail_C
DFC_DisblMsk.DFC_MoCROMErrXPg_C
DFC_DisblMsk.DFC_MoCSOPErrMMRespByte_C
DFC_DisblMsk.DFC_MoCSOPErrNoChk_C
DFC_DisblMsk.DFC_MoCSOPErrRespTime_C
DFC_DisblMsk.DFC_MoCSOPLoLi_C
DFC_DisblMsk.DFC_MoCSOPMM_C
DFC_DisblMsk.DFC_MoCSOPOSTimeOut_C
DFC_DisblMsk.DFC_MoCSOPPsvTstErr_C
DFC_DisblMsk.DFC_MoCSOPTimeOut_C
DFC_DisblMsk.DFC_MoCSOPUpLi_C
DFC_DisblMsk.DFC_PCRGovDvtMin_C
DFC_DisblMsk.DFC_PIntkVUsPhysRngHi_C
DFC_DisblMsk.DFC_PTrbnUsPlaus_C
DFC_DisblMsk.DFC_RailPSRCMax_C
DFC_DisblMsk.DFC_Tprot_Rttp_Err_C
DFC_DisblMsk.DFC_TrbChOLB2_C
EGTCond_nEngMaxCSH_C
EngDa_trqEngMax_C
EngDem_trqLimErr3_MAP
EngPrt_qLim_CUR
EngPrt_trqNLim_CUR
EngPrt_trqNLimSpr_CUR
EngPrt_trqOvhtPrvNRng_MAP
EngPrt_trqOvhtPrvVRng_MAP
EngPrt_trqPresCor_MAP
EngPrt_trqTempCor1_MAP
EngPrt_trqTempCor2_MAP
EngPrt_trqTempCor3_MAP
EngPrt_trqTempCor4_MAP
FMO_pPCRGovThres_C
Rail_dvolMeUnCtlUpLim_C
Rail_dvolMeUnCtlUpLim_CUR
Rail_pMeUnDvtMax_CUR
Rail_pMeUnDvtMin_CUR
Rail_pMonDvtMax_C
Rail_qRedOfsLimHi_C
Rail_qThresOfsHi_C
RngMod_trqSpd_CUR
SmkLim_qBlSmkMinMax_C
SmkLim_rLamSmkNrmMode_MAP

**Labels that changed (continued)**

I14229Appl_Std_xCalPartNum_ASC
InjCrv_phiMI1Bas1Cfg1EOM0_MAP
InjCrv_phiMI1Bas1Cfg1EOM3_MAP
InjCrv_phiMI1Bas1Cfg2EOM0_MAP
InjCrv_phiMI1Bas1Cfg3EOM0_MAP
InjCrv_phiMI1Bas1Cfg3EOM3_MAP
InjCrv_phiMI1Bas1Cfg4EOM1_MAP
InjCrv_phiMI1Bas1Cfg4EOM2_MAP
InjCrv_phiMI1Bas1Cfg4EOM3_MAP
InjCrv_phiMI1Bas1Cfg5EOM1_MAP
InjCrv_phiMI1Bas1Cfg5EOM4_MAP
InjCrv_phiMI1Bas1Cfg6EOM1_MAP
InjCrv_phiMI1Bas1Cfg7EOM2_MAP
InjCrv_phiMI1Bas1Cfg8EOM2_MAP
InjCrv_phiMI1Bas2Cfg1EOM0_MAP
InjCrv_phiMI1Bas2Cfg1EOM3_MAP
InjCrv_phiMI1Bas2Cfg2EOM0_MAP
InjCrv_phiMI1Bas2Cfg2EOM3_MAP
InjCrv_phiMI1Bas2Cfg3EOM0_MAP
InjCrv_phiMI1Bas2Cfg3EOM3_MAP
InjCrv_phiMI1Bas2Cfg4EOM0_MAP
InjCrv_phiMI1Bas2Cfg4EOM3_MAP
InjCrv_phiMI1Bas3Cfg1EOM3_MAP
InjCrv_phiMI1Bas3Cfg2EOM0_MAP
InjCrv_phiMI1Bas3Cfg2EOM3_MAP
InjCrv_phiMI1Bas3Cfg3EOM0_MAP
InjCrv_phiMI1Bas3Cfg3EOM3_MAP
InjCrv_phiMI1Bas3Cfg4EOM0_MAP
InjCrv_phiMI1Bas3Cfg4EOM3_MAP
InjCrv_phiMI1Bas4Cfg1EOM3_MAP
InjCrv_phiMI1Bas4Cfg2EOM0_MAP
InjCrv_phiMI1Bas4Cfg2EOM3_MAP
InjCrv_phiMI1Bas4Cfg3EOM0_MAP
InjCrv_phiMI1Bas4Cfg3EOM3_MAP
InjCrv_phiMI1Bas4Cfg4EOM0_MAP
InjCrv_phiMI1Bas4Cfg4EOM3_MAP
InjVlv_tiET_MAP
InjVlv_tiWup2On_C
LLim_vMaxFix_C
MoCMem_ctDebHealChkRAM_C
MoCMem_ctDebHealChkRAMCpl_C
MoCMem_ctDebHealChkROM_C
MoCMem_ctDebHealChkROMCpl_C
MoCRam_noRAMChkSD_CW
MoCRom_noROMChkIni_CW
MoCRom_noROMCodeChkRst_CW
MoCRom_noROMDataChkRst_CW
MoFDrDem_rTrqEng_MAP
MoFTrqIdc_q2trq_MAP
MoFTrqIdc_q2trq2_MAP
PCV_dvolUpLim_CUR
PPC_CHIPID
urlc_enable_shutdown_end
VehV_vMax_C

## Calibration File Compare: SCT 3015R (Returned to Stock Calibration)

| Feature | Comments |
| --- | --- |
| Return to stock | Looks to have returned to stock |

**Labels that changed**

DFC_CtlMsk.DFC_MoCROMErrXPg_C
DFC_DisblMsk.DFC_MoCROMErrXPg_C
I14229Appl_Std_xCalPartNum_ASC
MoCMem_ctDebHealChkRAM_C
MoCMem_ctDebHealChkRAMCpl_C
MoCMem_ctDebHealChkROM_C
MoCMem_ctDebHealChkROMCpl_C
MoCRam_noRAMChkSD_CW
MoCRom_noROMChkIni_CW
MoCRom_noROMCodeChkRst_CW
MoCRom_noROMDataChkRst_CW
PPC_CHIPID

## APPENDIX G
## MISCELLANEOUS EMAIL COMMUNICATION

>>> [redacted] 1/10/2014 2:55 PM >>>

Don't worry about the 15th…My management probably won't want to see that level of detail.

Yes, the difference in emissions is because we ran hot 74's and not a 75 procedure that includes a cold start. A cold start is where most of the emissions are generated. Of course, Ann suggested hot 74's at the start of this…and that was good because we would have never completed the testing by running 75's. The EPA75 requires a 12 hour soak before each test, so at best we would have been able to run only one test per day.

[redacted]

---

From: [redacted]
Sent: Friday, January 10, 2014 2:47 PM
To: [redacted]
Subject: RE: Baseline US06

[redacted]

Attached is an updated table of results. Usually these types of things would need to go through an internal review at my company but I don't think I would have enough time to get that step done by 1/15. I will let you know if I find any errors when I get to that step.

Can you speculate as to why the baseline FTP 74 results are so low compared to certification levels (even without DF's or EAFs added in)? For example, the cert level for NOx, according to public EPA documents, is 0.3 g/mi but our baseline is around 0.03 (DF 0 and EAF is only 0.02). I guess what I'm trying to confirm is the big differences between the 74 and 75 from a procedure point of view that would cause an order of magnitude change in measurements?

**From:** [redacted]
**To:** [redacted]
**Subject:** RE: Questions about Testing
**Date:** Friday, March 07, 2014 3:44:29 PM
**Attachments:** image002.png

---

Sorry for the delayed response…

Hope you're doing well. I put together a list of follow up questions below. No rush on the response but I couldn't find a complete list in my notes so I figured this would help both of us. Number 3 and 4 don't really require an answer.

1. Confirm that the 0.0072 g/mi PM measurement on the US06 Spartan was actually for the last bag or if it represents the measurement for the last two bags due to an issue the during testing. I attached the previous email chain for your reference. Yes the .0072 was for the final test…It's just the form layout that makes it appear weird, but it is indeed the total, one-test, final US06 particulate mass.

2. Can you confirm that the following equation is how one would calculate cumulative fuel consumption for each interval (second).

$$Fuel\ (mg) = \sum RPM_{inst}\left(\frac{revoltions}{ms}\right) \times Fuel_{inst}\left(\frac{mg}{stroke}\right) \times \left(\frac{2\pi}{revolution}\right) \times \left(\frac{180\ degrees}{\pi}\right) \times \left(\frac{1\ stroke}{720\ degrees/cylinder}\right) \times 8\ (cylinders)\ \times \Delta Time$$

This would be a perfectly valid method to calculate fuel consumption

3.Second US06 baseline test in order to gather data on the data logger. I am having a hard time getting into our busy cert schedule. I am not sure I will ever make it onto the priority list. I think our day in the sun is over.

4. Calibration file compare . I have preliminary file compare info. …It has the important stuff complete. The person performing the file compare felt uncomfortable about letting our Ford strategy information out in an uncontrolled document, so I have his summarization that I will forward in a just a few minutes.

[redacted]

**From:** [redacted]
**Sent:** Wednesday, March 05, 2014 3:57 PM
**To:** [redacted]
**Subject:** Questions about Testing

[redacted]

Hope you're doing well. I put together a list of follow up questions below. No rush on the response but I couldn't find a complete list in my notes so I figured this would help both of us. Number 3 and 4 don't really require an answer.

1. Confirm that the 0.0072 g/mi PM measurement on the US06 Spartan was actually for the last bag or if it represents the measurement for the last two bags due to an issue the during testing. I attached the previous email chain for your reference.
2. Can you confirm that the following equation is how one would calculate cumulative fuel consumption for each interval (second).

$$Fuel\ (mg) = \sum \boldsymbol{RPM}_{inst} \left(\frac{revoltions}{ms}\right) \times \boldsymbol{Fuel}_{inst} \left(\frac{mg}{stroke}\right) \times \left(\frac{2\pi}{revolution}\right) \times \left(\frac{180\ degrees}{\pi}\right) \times \left(\frac{1\ stroke}{720\ degrees/cylinder}\right) \times 8\ (cylinders)\ \times\ \boldsymbol{\Delta Time}$$

3. Second US06 baseline test in order to gather data on the data logger
4. Calibration file compare

[redacted]

[redacted]

## Brent Ruminski

**From:** "Wick, Anne" <Wick.Anne@epa.gov>
**Sent:** Thursday, August 01, 2013 9:41 AM
**To:** Brent.Ruminski@erg.com
**Subject:** RE: H&S question

H&S said that they would evaluate whether the new unlock code algorithm was “safe” and were willing to eliminate the race tunes if “hacking” was still occurring. EPA told H&S that we believed there was wide availability of the unlock codes and asked H&S to make good on their offer to eliminate the race tunes. That is what they claim they did with production starting around July 11, 2013.

Anne Wick, Mechanical Engineer
Vehicle and Engine Team Leader
202-564-2063

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**From:** Brent Ruminski [mailto:Brent.Ruminski@erg.com]
**Sent:** Friday, July 26, 2013 4:31 PM
**To:** Wick, Anne
**Subject:** H&S question

Anne,

For the final report, I need a short blurb about the events that occurred between EPA and H&S that we may not have been involved in. It really just needs to be 1-2 sentences that includes the following:

-Did H&S offer to stop selling DPF/EGR delete tuners or did EPA order them to stop, I think EPA ordered them to stop. If so, wha tis the general name that you would call this order "cease of production order"
-What is the date H&S was supposed to have ceased production of certain tuners
-What specific type of tuners were they supposed to stop selling

Thanks Anne! Have a good weekend,
Brent

From: [redacted]
To: [redacted]
Subject: RE: Diesel Tuner Device Testing: ECM swap notes
Date: Monday, March 10, 2014 1:05:56 PM

ASMOD EGR is *"mass flow downstream of the EGR cooler".*

If it's %, It must be calculated from a delta pressure flow sensor with the raw reading must go through a bunch of manipulation until a % EGR of intake air is calculated. From the description, I believe this is the meaning. Regardless of exact definition, it certainly is an indication of EGR flow after the cooler and into the intake.

[redacted]

From: [redacted]
Sent: Monday, March 10, 2014 11:57 AM
To: [redacted]
Subject: RE: Diesel Tuner Device Testing: ECM swap notes

[redacted]

I came up with one more question, can you provide a definition/description of the data parameter: "ASMOD EGR rate" in the data logger. The units are %.

I am proposing "ASMOD EGR rate" as the indicator that the EGR was either working or not working during tests. There is also a EGR valve (%) and desired EGR rate (%) in the data but I can't use them because the Spartan street tune defaulted those values to 0, even though we know the EGR was in fact working (based on emission results and the fact that the cumulative AFR did not increase substantially).