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# SMART Emissions Reducer Trial Program Data Report

## Philadelphia Parking Authority



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Philadelphia, PA 19104

June 28<sup>th</sup>, 2013



## Philadelphia Parking Authority Trial Report

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Extreme Energy Solutions conducted a 90 Day Trial Program of the SMART Emissions Reducer with the Philadelphia Parking Authority on 3 classes of vehicles:

1. 2012 Ford Focus
2. 2012 Ford E-250 vans
3. 2012 Dodge Ram Tow Trucks

For each class, 2 vehicles were retrofitted with the Smart Emissions Reducer. In addition to the test vehicles, a third of each class was monitored without a SMART Emissions Reducer for fuel economy and emissions as a comparable. Since these vehicles were almost brand new at the start of the test trial, the comp vehicle allowed for expected change in climate and break-in variations. Baseline emissions readings were taken at the time of installation for the 6 test vehicles, then at the 30, 60, and 90 day intervals. The comp vehicles were not emissions tested at the start of the program (on installation date), but were tested at the 30 day intervals. Averages of the 2-per-class vehicles were assigned to the comp vehicles, and these numbers are denoted in [brackets] in the charts.

The trial program began March 11, 2013. Emissions test and device cleaning intervals were conducted on April 8, May 13, and June 10. The 30 day readings for the tow trucks were taken on April 22, as the battery in the opacity meter was dead on April 8.

Mr. Kenneth Henshaw was instrumental in providing fuel economy logs for vehicles specific to The Philadelphia Parking Authority 90-Day Smart Emissions Reducer Trial Program. Furthermore, Mr. Henshaw cooperated in every effort in making available vehicles allocated to the study during the 30, 60, and 90 day benchmarks. He acknowledged that vehicle #230 became incapacitated due to an accident. Extreme Energy Solutions, Inc did not remove the Smart Emissions Reducer from this vehicle as per instructions of Mr. Henshaw.

Fuel economy numbers for the tow trucks and vans were reasonably accurate. The Focus group, however, had missing data that leaves the fuel economy data inconclusive (see section on Focus). In short, the tow trucks averaged a **36.5% increase** in fuel economy and the van that finished the test a

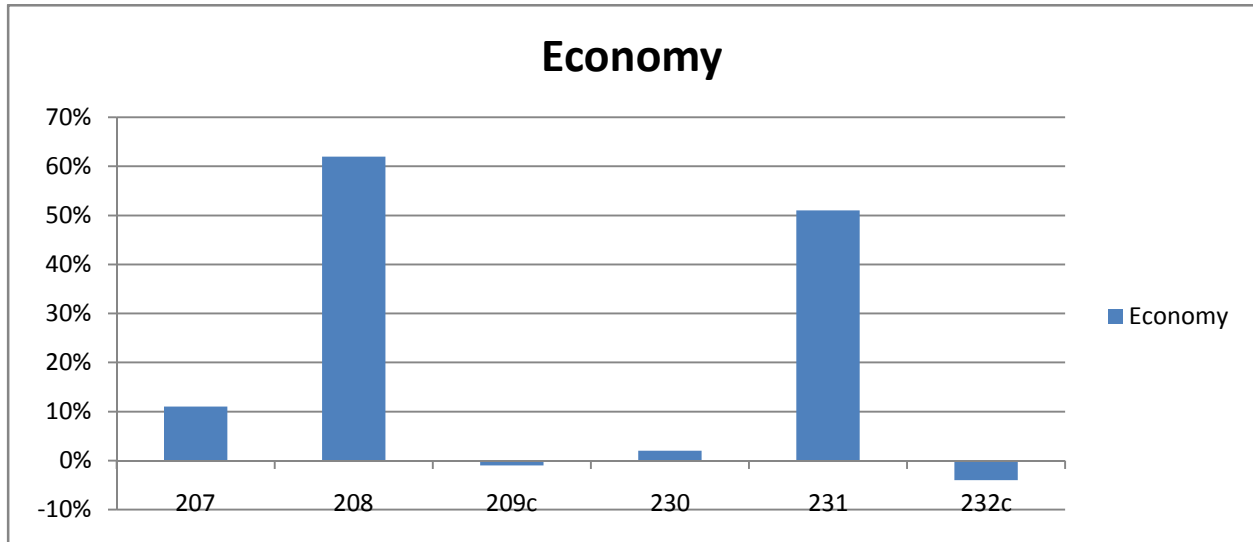
**51% increase.** The tow truck comp experienced a 1% decrease, while the van comp experienced a 4% decrease.

With the exception of the comp van's NO<sub>x</sub>, all vehicles showed a decrease in emissions throughout the test period.

This Report has been prepared by Mike Holler, National Tech Director for Extreme Energy Solutions on June 20, 2013.

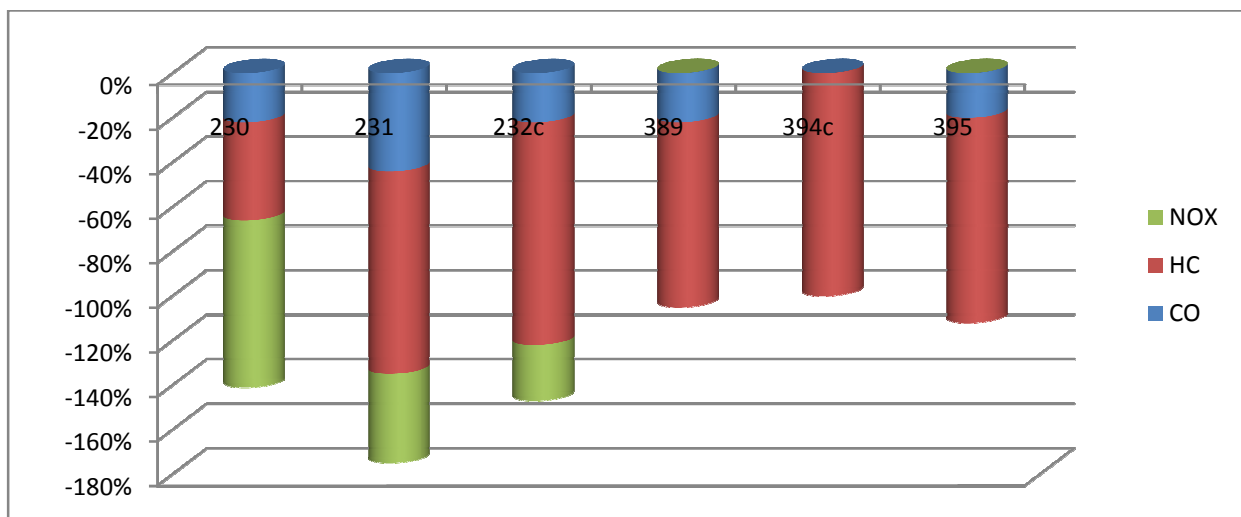
# At A Glance

## Fuel Economy



The fuel economy gains were quite substantial. Tow truck #207 achieved an **11% gain**, #208 achieved a whopping **62% gain**, while comp vehicle #209 experienced a 1% loss. Van #230 was wrecked part way through the trial, but still managed to show a **2% increase** in fuel economy. Van #231 earned a nice **51% gain**, while comp vehicle #232 lost 4%. The Focus group experienced a **14%** (#389) and **18.3% gain** (#395).

## Emissions



Overall emissions were reduced by 53.3% on the test vehicles, while the emissions on the comp vehicles came down by 41% due to normal break-in. This yields a net **reduction in emissions by 12%**.

# Full Review

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The test program ran from March 11 to June 10, 2013. Extreme Energy Solutions monitored exhaust emissions starting on March 11 prior to installation of the Smart Emissions Reducer. Readings were then taken approximately every 30 days, ending on June 10. Fuel economy data was collected by the Philadelphia Parking Authority, as recorded by the Driver's Logs (included as an addendum in the Full Report).

## Rules

Since the trial was conducted on virtually brand new vehicles, some special considerations must be taken to ensure accurate assessment of real gains. A "Comp" vehicle was monitored for each category to account for engine break-in, temperature changes between March and June, fuel differences between winter and summer blends, and so forth. Therefore, fuel economy and emissions will be compared both as "before and after" and "modified versus stock" to get a clearer understanding of the true value of the Smart Emissions Reducer.

For return on investment (ROI) and annual savings, fuel is estimated at \$3.30 per gallon for gasoline and \$3.75 for diesel. The total number of days for the trial program is 91. (Some of the vehicles were calculated at less than 91 days.) The total number of miles were tallied, divided by the number of days, then multiplied by 365 to establish an estimated annual mileage accumulation for the vehicles. Old fuel economy numbers were used to determine fuel costs without the Smart Emissions Reducer, and new fuel economy numbers were used to determine fuel costs with. The difference is annual savings.

## 2012 Ford E-250 # 232

Van #232 was our comp vehicle for the van class.

<b>232c</b>	March	April	May	June	<b>Change</b>
<b>CO</b>	[0.09%]	0.08%	0.10%	0.07%	<b>-22.00%</b>
<b>HC</b>	[10 ppm]	3 ppm	9 ppm	0 ppm	<b>-100%</b>
<b>NO<sub>x</sub></b>	[4 ppm]	0 ppm	2 ppm	3 ppm	<b>-25%</b>
<b>CO<sub>2</sub></b>	[15.4%]	15.50%	15.40%	15.30%	<b>-0.65%</b>
<b>O<sub>2</sub></b>	[.08%]	0.03%	0.01%	0.02%	<b>-75%</b>

As can be seen from the chart above, even the stock vehicle cleaned up the HC, NO<sub>x</sub>, and CO emissions as the engine got broken in. The March numbers in [brackets] is estimated by averaging the March numbers from vans #230 and #231.

<b>232c</b>	<b>March</b>	<b>April</b>	<b>May</b>	<b>Change</b>
<b>Miles</b>	619	1008	664	
<b>Gals</b>	77.1	136.3	86.1	
<b>Fe</b>	8.03	7.4	7.71	<b>-4%</b>

The fuel economy remained fairly stable throughout the test period, netting a minor 4% loss.

## 2012 Ford E-250 # 230

This van experienced a front end collision on May 6, and was out of commissions for the remainder of the trial period. However, there are some initial readings on both fuel economy and emissions.

<b>230</b>	<b>March</b>	<b>April</b>	<b>Change%</b>
CO	0.09%	0.07%	<b>-22%</b>
HC	9 ppm	5 ppm	<b>-44%</b>
NO <sub>x</sub>	4 ppm	1 ppm	<b>-75%</b>
CO <sub>2</sub>	15.50%	15.40%	<b>-0.64%</b>
O <sub>2</sub>	0.12%	0.07%	<b>-42%</b>

As can be seen from the above chart, emissions were moving in the right direction.

<b>230</b>	<b>March</b>	<b>April</b>	<b>Change</b>
<b>Miles</b>	976	964	
<b>Gals</b>	124	119.9	
<b>Fe</b>	7.87	8.04	<b>2%</b>

Comparing the end fuel economy for #230 against the end fuel economy for our comp vehicle #232, the result would be a **4.1% gain**. No ROI or annual savings were calculated for this vehicle.

## 2012 Ford E-250 # 231

<b>231</b>	<b>March</b>	<b>April</b>	<b>May</b>	<b>June</b>	<b>Change%</b>
<b>CO</b>	0.09%	0.07%	0.09%	0.05%	<b>-44%</b>
<b>HC</b>	11 ppm	9 ppm	7 ppm	1 ppm	<b>-90.90%</b>
<b>NO<sub>x</sub></b>	5 ppm	1 ppm	4 ppm	3 ppm	<b>-40%</b>
<b>CO<sub>2</sub></b>	15.40%	15.50%	15.30%	15.30%	<b>-0.65%</b>
<b>O<sub>2</sub></b>	0.03%	0.08%	0.23%	0.06%	<b>100%</b>

There is a dramatic reduction in emissions in the critical toxic categories of CO, HC, and NO<sub>x</sub>. CO was reduced twice as much as the comp vehicle #232, with final reading being 28.6% lower than #232. HC showed an insignificant 1 ppm at the end of the test, and the NO<sub>x</sub> ended at the same 3 ppm as the comp #232.

<b>231</b>	<b>April</b>	<b>May</b>	<b>June</b>	<b>Change</b>
<b>Miles</b>	900	1214	1265	
<b>Gals</b>	105.7	178.5	98.4	
<b>Fe</b>	8.51	6.8	12.86	<b>51%</b>

**Fuel economy improved by 51%** from the start to the end of the test. Comparing the end fuel economy for #231 against the end fuel economy for the comp #232, a **67% increase** is calculated.

The most significant reduction in emissions came in the CO category, with a net **28.6%** reduction when compared to the stock #232 vehicle. Fuel economy improvements range from **51% to 67%** depending on whether actual improvement or comparison against the stock van is considered.

**Annual savings** are estimated to be **\$2215.98** with a **ROI in 3 months**.

## 2012 Dodge Chassis Tow Truck – Cummins Turbo Diesel

To simplify, all 3 tow trucks will be lumped together.

	<b>March</b>	<b>April</b>	<b>May</b>	<b>June</b>	<b>Change%</b>
<b>207</b>	0.681	0	0.258	0%	<b>-100%</b>
<b>208</b>	0.989	0.055	0	0%	<b>-100%</b>
<b>209c</b>	NA	NA	0	0%	<b>0%</b>

Our comp vehicle #209 was not available for testing until our May visit. The net emissions result is that all 3 vehicles showed 0.00% PM at the end of the test. It is assumed that #209 would have shown between ½% and 1% PM if it had been tested in March.

	<b>207</b>	<b>208</b>	<b>209c</b>
<b>Miles-April</b>	1407	1297	1082
<b>Miles-May</b>	2033	2114	1291
<b>Miles-June</b>	1069	2025	1371
<b>Gallons-April</b>	201	196.2	121.5
<b>Gallons-May</b>	262.2	270.9	135.6
<b>Gallons-June</b>	130.2	188.5	155
<b>Fuel Economy-April</b>	7.4	6.61	8.9
<b>Fuel Economy-May</b>	7.75	7.8	9.52
<b>Fuel Economy-June</b>	8.21	10.74	8.84
<b>Change</b>	<b>11%</b>	<b>62%</b>	<b>(-1%)</b>

As can be seen in the above chart, our comp vehicle #209 remained fairly consistent in fuel economy between the start and end of the trial program. Comp vehicle #209 showed the highest starting fuel economy at 8.9 MPG. Vehicle #208 showed the lowest at 6.61 MPG. From start to end of trial program, vehicle #207 showed an **11% increase** in fuel economy, and vehicle #208 showed a **62% increase**. Comparing final numbers from the test vehicles against the comp, #207 showed a 7.1% loss, while #208 showed a 21.5% increase.

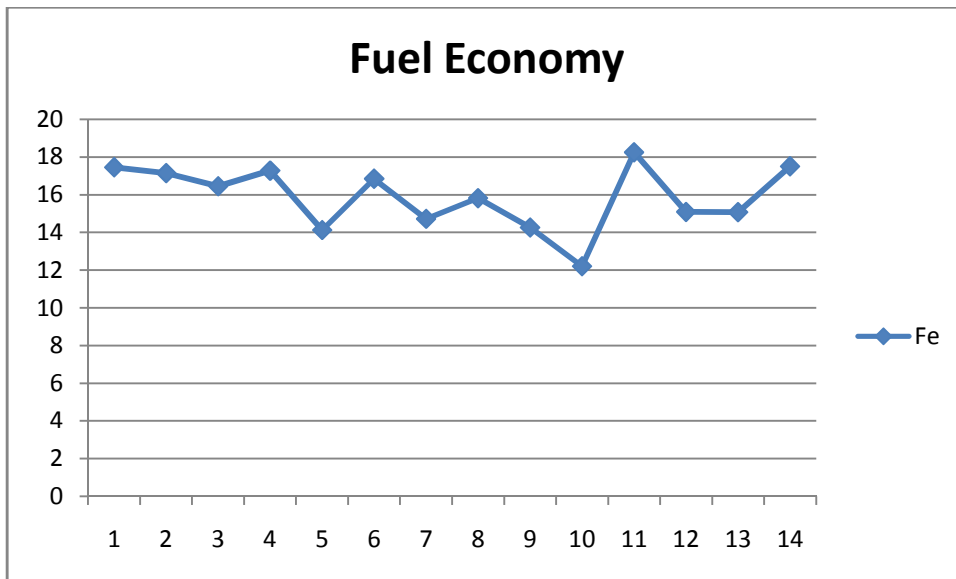
Vehicle #207 shows an estimated **annual savings of \$970.78, with a ROI of 8 months.**

Vehicle #208 shows an estimated **annual savings of \$5938.76, with a ROI of 40 days.**

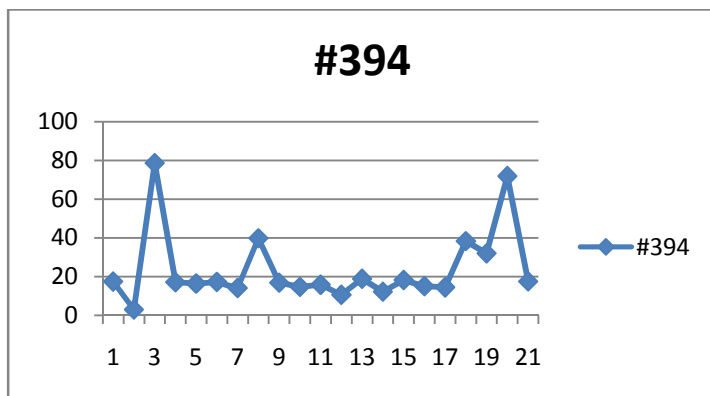
### 2012 Ford Focus #394 (Comp)

<b>CO</b>	[0.09%]	0.07%	0.09%	0.09%	<b>0.00%</b>
<b>HC</b>	[9 ppm]	1 ppm	5 ppm	0 ppm	<b>-100%</b>
<b>NO<sub>x</sub></b>	[0 ppm]	0 ppm	2 ppm	0 ppm	<b>0%</b>
<b>CO<sub>2</sub></b>	[15.6%]	15.60%	15.50%	15.60%	<b>0%</b>
<b>O<sub>2</sub></b>	[0.24%]	0.19%	0.16%	0.19%	<b>-20.8%</b>

Our comp vehicle for the Focus group was #394. Emissions ended very clean, with 0 ppm HC and NO<sub>x</sub>, and only 0.09% CO.



Our comp #394 fuel economy is graphed out above. There were missing entries, so data was selective, using only segments where fuel was recorded. Using the data without removing questionable segments the graph looks like this:



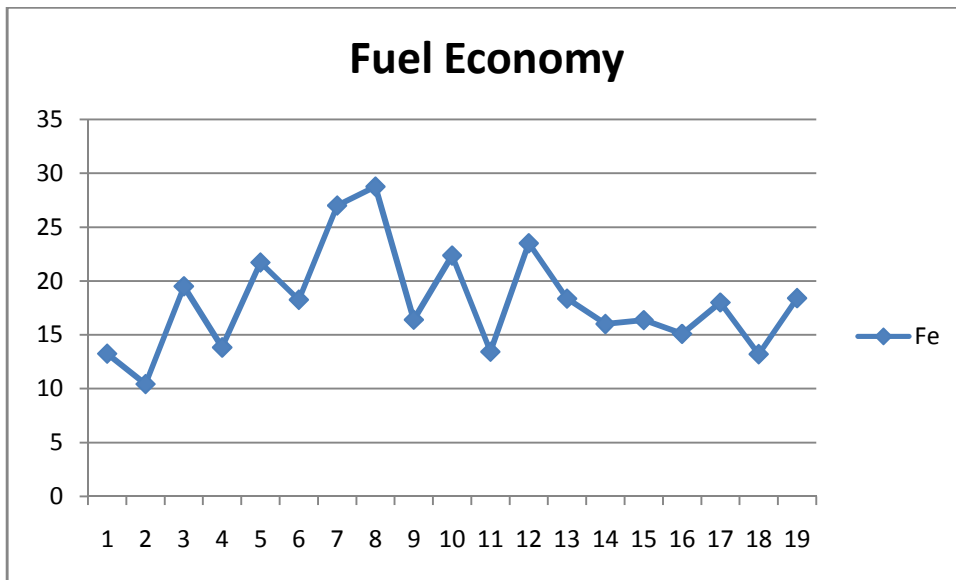


Fuel economy averaged 15.87 MPG throughout the trial program (using selected data).

### 2012 Ford Focus #389

	389	March	April	May	June	Change%
CO		0.09%	0.07%	0.08%	0.07%	-22%
HC		6 ppm	1 ppm	2 ppm	1 ppm	-83%
NO <sub>x</sub>		0 ppm	0 ppm	1 ppm	0 ppm	0%
CO <sub>2</sub>		15.60%	15.50%	15.60%	15.50%	-0.64%
O <sub>2</sub>		0.22%	0.16%	0.18%	0.17%	-22.7%

The toxic emissions all went down by a respectable amount. CO ended up 22% lower than our comp #394. HC showed an insignificant 1 ppm, while NO<sub>x</sub> was eliminated.



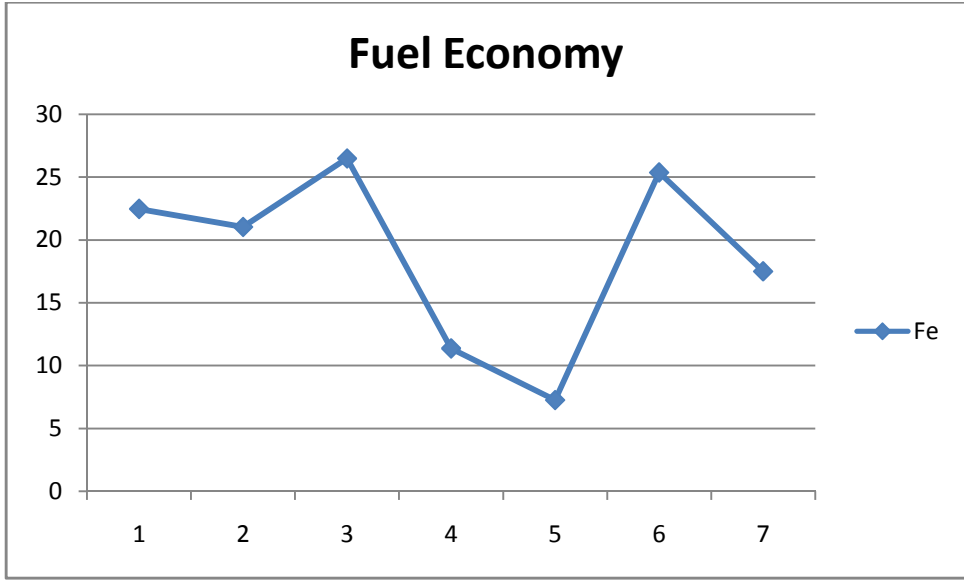
Total average fuel economy was 18.09 MPG. This represents a **14% increase** over the comp vehicle #394.

Estimated annual savings are **\$571.23**, with a **ROI in 11 months**.

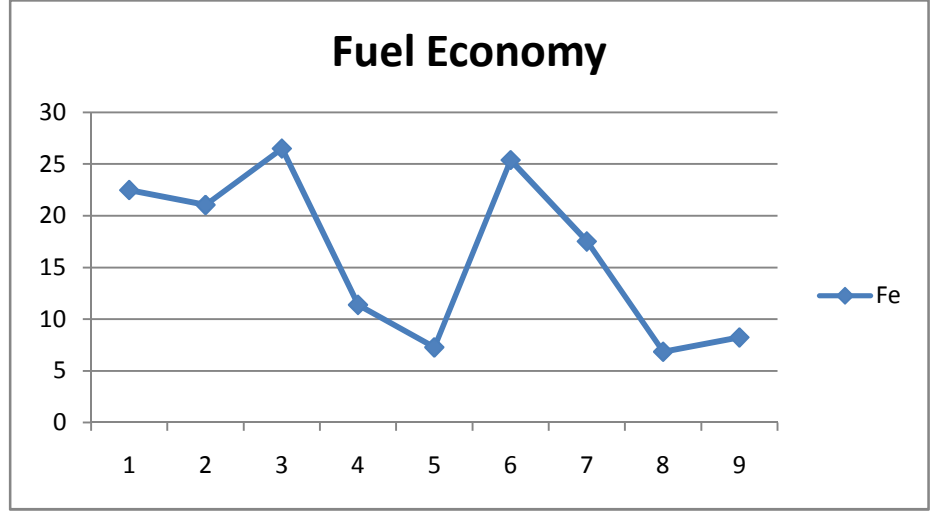
### 2012 Ford Focus #395

CO	0.10%	0.09%	0.10%	0.08%	-20%
HC	13 ppm	5 ppm	11 ppm	1 ppm	-92%
NO <sub>x</sub>	0 ppm	0 ppm	0 ppm	0 ppm	0%
CO <sub>2</sub>	15.60%	15.50%	15.50%	15.30%	-1.90%
O <sub>2</sub>	0.26%	0.14%	0.19%	0.04%	-84.6%

CO emissions ended 11% lower than the comp vehicle #394. HC ended with an insignificant 1 ppm, a 92% reduction from the start of the trial. No NO<sub>x</sub> was detected throughout the entire program.



Fuel economy for #395 also showed some wild swings, even removing some of the most questionable data. Overall fuel economy averaged 18.78 MPG, which is an **18.3% increase** over the comp #394. Without removing the questionable data the chart looks like:



Estimated annual savings are **\$451.80**, with a **ROI in 14 months**.

# Summary

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	<b>230</b>	<b>231</b>	<b>389</b>	<b>395</b>	<b>207</b>	<b>208</b>	<b>Average</b>
<b>CO</b>	-22%	-44%	-22%	-20%			<b>-27%</b>
<b>HC</b>	-44%	-90.90%	-83%	-92%			<b>-77.50%</b>
<b>NO<sub>x</sub></b>	-75%	-40%	0%	0%			<b>-28.75%</b>
<b>CO<sub>2</sub></b>	-0.64%	-0.65%	-0.64%	-1.90%			<b>-0.96%</b>
<b>PM</b>					-100%	-100%	<b>-100%</b>
<b>FE</b>	4.10%	67%	14%	18.30%	11%	62%	<b>29.40%</b>

All test vehicles showed dramatic reductions in toxic emissions, ranging from 20% to 100%. Fuel economy gains ranged from 4.1% to 67%. **Average fuel economy increase was 29.4% overall.**

	<b>230</b>	<b>231</b>	<b>389</b>	<b>395</b>	<b>207</b>	<b>208</b>
<b>\$Savings</b>	\$150.95	\$2,215.98	\$571.23	\$451.80	\$970.78	\$5,938.76
<b>ROI</b>	NA	3 Months	11 Months	14 Months	8 Months	40 Days

**Average annual savings (excluding #230) is \$2029.71, while average ROI is 7.46 months.**