Cal-Cat Diesel Report

The extensive information in this report is provided to be a guide to better understand the current emission testing that was done to validate the function and performance of the "Cal-Cat" developed by Panther Performance Technologies, and the positive effect it has in reducing diesel emissions. Panther Performance Technologies developed the Cal-Cat as a performance enhancement product for gasoline and diesel powered vehicles. Through our private testing we discovered that the Cal-Cat increased engine performance and torque while consistently reducing emissions and fuel consumption of both gasoline and diesel vehicles.

Emissions Report

The third party testing data done by a licensed New Jersey State Diesel Emission center supported our findings on the test vehicle in this report. The test vehicle to date has shown an average of 24.73% reduction in diesel particulate emissions from its stock baseline after modification in increments of 1% initially, 10.75% by the second week and 24.73% by the third week. This supports our finding of how the Cal-Cat performs better after a short break-in period of usually 3-6 driving thermal cycles. Part of this increase in the emission reduction performance is believed to be in the cleaner combustion enhancement from the Cal-Cat removing deposits in the engine and exhaust. The Rise Time, which is the time it takes for the engine to go from its minimum RPM to its maximum RPM was also reduced by a full tenth of a second for a 7.5% decrease in rise time improvement, showing an increase in engine performance. Fuel efficiency has also improved from 22-29% depending on the varying workload of the vehicle (up to 80,000 pound loads) while the driver reports that the vehicle pulls hills better fully loaded or empty.

While there are many new retrofit Regenerative Particulate Emission Filter systems and Diesel Oxidation Catalyst systems being mandated for diesel powered vehicles operated in major cities, including mass transit vehicles. Most of these regeneration systems increase fuel consumption as well as downtime of the vehicle up to 30-45 minutes, while the vehicle regenerates its filters. This adds to the operating cost of the vehicle in addition to the inconvenience and discomfort of the passengers using mass transit, which is a predictor of further revenue loss to the cities due to passengers using other means of transportation including

driving their own vehicles. Loss of mass transit users can potentially nullify the reduction in diesel emissions by putting additional vehicles on the road and into traffic congestion further increasing emissions and fossil fuel consumption. In a recent Fire and EMS blog called Statter911 by Dave Statter he did a story on the Boca Raton Fire Department and the trouble they were having with the regenerative system on their new Fire trucks. Imagine an emergency response vehicle rushing to save lives and shutting down for 30-45 minutes to regenerate its Diesel Particulate Filters. In an emergency time means lives. The complete article can be read at Statter911 http://statter911.com/2010/04/18/the-regeneration-gap-a-fire-chief-wrestles-with-front-line-apparatus-time-outs-due-to-epa-diesel-emission-regulations/

The Cal-Cat offers a positive solution to these problems by increasing combustion performance and power with no down time thus, reduces emissions in the combustion power stroke of the engine in addition to reduced fuel consumption. The Cal-Cat's ability to lower particulate emission 25% or more would mean fewer regenerative cycles on vehicles equipped with these systems which would be a savings proportionately to the amount of fuel used in the regenerative cycle, in addition to the fuel reduction it offers in the combustion cycle and most importantly can help save lives

Increased Torque

Torque in engineering terms also known as "moment of force" is the propensity of force to rotate an object about its axis, pivot point, or fulcrum. Engine torque is the twisting force the engine applies to the crankshaft, increasing engine torque at lower RPM enables the engine's ability to perform usable work with less fuel demand under heavy loads. Diesel engines by the nature of their design produce high torque at low rpm with proportionately less fuel than a gasoline engine making them the best work engine. The Cal-Cat enhances torque through enhanced combustion by breaking down the larger Hydrogen/Carbon bonds in the fuel that normally do not combine with oxygen in time to produce heat in the combustion cycle generating power, instead of excess waste heat and particulate emissions in the exhaust.

The following information is provided directly from the New Jersey Environmental Protection, Environmental Regulation Office of Air Quality Management it is being included here to better explain our attached test results of the Cal-Cat so that correlations can be made to other state's standards.

NOTE: THIS IS A COURTESY COPY OF THIS RULE PROPOSAL. THE OFFICIAL VERSION WILL BE PUBLISHED IN THE JUNE 16, 2008, NEW JERSEY REGISTER (40 NJR 6/21 JUNE 16, 2008). SHOULD THERE BE ANY DISCREPANCIES BETWEEN THIS TEXT AND THE OFFICIAL VERSION OF THE PROPOSAL, THE OFFICIAL VERSION WILL GOVERN. 1

ENVIRONMENTAL PROTECTION
ENVIRONMENTAL REGULATION
OFFICE OF AIR QUALITY MANAGEMENT
Control and Prohibition of Air Pollution from Diesel-Powered Motor Vehicles
(Diesel Powered Motor Vehicle Inspection and Maintenance Program)

The Department is proposing to amend N.J.A.C. 7:27-14, Control and Prohibition of Air Pollution from Diesel-Powered Motor Vehicles, to reduce the opacity cutpoints, strengthen the visible smoke standard for diesel-powered trucks and buses, and clarify the rules' exemption for emergency vehicles. This rulemaking is a part of the Department's Statewide effort to reduce diesel exhaust emissions from diesel-powered vehicles. This proposal also represents a revision to the State Implementation Plan.

Diesel exhaust contains particulate matter in several size ranges, from coarse soot that can actually be seen as individual particles, to virtually invisible ultra-fine particles less than one micron in diameter ($PM_{1.0}$). In this proposal, the term "particulate matter" or "PM" means the mostly visible particle fraction, including particles up to 10 microns in diameter (PM_{10}). Although the opacity measurement technique utilized in the Diesel Powered Motor Vehicle Inspection and Maintenance Program (Diesel Inspection Program) focuses on PM_{10} emissions,

reductions of particulate matter less than 2.5 microns in diameter ($PM_{2.5}$, which is a fraction of PM_{10}) will also occur when a vehicle is properly maintained.

Diesel-powered engines, such as those found in trucks and buses, are responsible for a significant amount of the particulate pollution in New Jersey, which can disproportionately affect people in densely populated high traffic areas, especially in urban centers. The emission of particulate matter and other chemical compounds in the exhaust of diesel engines pose a real health risk to the people of the State. Analysis of data from the Department's air monitoring system shows that diesel emissions contribute up to 12 percent of the particulate matter 2.5 microns or less in diameter in the State.[1]

Scientific and academic studies have repeatedly shown links between exposure to fine particles and health effects, including premature death and increased incidents of asthma, allergies, and other breathing disorders.

A recent report by the New Jersey Clean Air Council states that only smoking and obesity outrank exposure to particulate matter in the estimated number of premature deaths caused every year.[2] Asthma and emphysema are exacerbated by particulate matter in the atmosphere. The United States Environmental Protection Agency (USEPA)[3] and the California Air Resources Board (CARB)[4] have classified diesel exhaust as a substance carcinogenic to humans, and have also identified diesel particulate matter and diesel exhaust organic gases as mobile source air toxics (a group of pollutants for which there is no national air quality standards, but that are likely to be emitted into the air in sufficient quantities to cause adverse health effects).

Fine particle emissions from diesel engines can be reduced by implementing stricter diesel emission cutpoints and idling regulations, encouraging the use of truck stop electrification and auxiliary power units, retrofitting diesel engines with particulate control devices, and increasing public awareness of diesel exhaust health effects through an anti-idling campaign. To that end, a law was enacted in 2005 creating a mandatory diesel retrofit program for approximately 40,000 existing diesel-powered vehicles and pieces of equipment throughout the State that are publicly owned, or are privately owned and are under contract to a public agency. (See P.L. 2005, c..

219.) The proposed stricter cutpoints are a concurrent effort intended to provide additional reductions of particulate matter and diesel exhaust by encouraging better maintenance and repair practices.

Smoke opacity, which is an indicator of particulate matter, is the degree to which a plume of smoke will obstruct transmission of visible light. It is typically expressed as a percentage of obstructed light. When the Department adopted the existing smoke opacity cutpoints in 1998 (30 N.J.R. 901(a) and 2476(b)), excessively smoking diesel-powered vehicles were a common sight on the State's roads and highways. Enforcement of the State's opacity cutpoints has made those excessively smoking vehicles the exception, rather than the rule.

There are approximately 70,000 heavy-duty diesel vehicles with a gross vehicle weight rating equal to or greater than 18,000 pounds in the New Jersey fleet of registered vehicles that are inspected under the Diesel Inspection Program. Inspection data collected since the beginning of the Diesel Inspection Program in 1998 show progressive improvement in smoke emissions to the point where today approximately 98 percent of the New Jersey registered heavy-duty diesel vehicles (trucks) with a GVWR equal to or greater than 18,000 pounds pass the existing opacity test by more than 30 percentage points on average. Opacity is measured on a scale of zero to 100 percent. For example, most engines subject to a cutpoint of 55 percent opacity would pass inspection and emit smoke at only 25 percent opacity.

Although the majority of the fleet complies with the existing opacity cutpoints, compliance does not necessarily result in achieving the best possible emission reduction; an improperly performing engine can pass inspection at the existing cutpoints. Currently available control technology allows diesel engines to emit at rates much lower than the existing cutpoints, when operating in accordance with the manufacturers' specifications. The proposed amendments to the rules governing the Diesel Inspection Program will be in step with the current diesel engine technology. As diesel engine technology becomes more effective at reducing emissions, it is appropriate that the cutpoints become more stringent to encourage owners and operators to ensure that the technology is operating properly, thereby avoiding reasonably preventable emissions.

Excessive smoke opacity is an established indicator of improper performance and poor maintenance. Regular maintenance and common engine repairs help to control emissions of diesel exhaust particles and reduce other pollutants. Reducing the opacity cutpoints for heavy-duty diesel vehicles and diesel buses will result in the reduction of visible quantities of particulate matter, including soot and air toxics throughout the State. The proposed stricter cutpoints are based on an analysis of the periodic inspection records collected from 1998 through 2003. The data indicate the fleet performs at smoke opacity emission levels significantly below the existing standard. In developing the proposed cutpoints for a given engine model year, the Department took into account the average opacity value of those vehicles that passed the periodic inspection. It then considered how often diesel engines of that model year achieved the same opacity value during inspection. This data analysis indicated three opacity groups, very closely aligned with the level of engine control technology.

As with the existing cutpoints, the older engines, controlled mechanically rather than electronically, would be subject to the least stringent cutpoint. Newer electronically controlled engines, with various mechanical enhancements, would be subject to more stringent cutpoints. The proposed stricter cutpoints are a logical extension of the Department's existing program. No new test method, procedure or equipment is required. In most cases, existing engines will be able to meet the proposed cutpoints by following the manufacturers' recommended maintenance practices, or by repairing commonly occurring mechanical faults.

Although newer diesel-powered vehicles and equipment usually operate more cleanly and contribute less to air quality problems than their predecessors, diesel-powered trucks and buses tend to remain in service for 20 years or more. Unless existing diesel-powered trucks and buses that operate in the State are properly maintained and repaired, such that the emissions from them are reduced, these trucks and buses will continue to contribute significantly to air pollution in the State for many years to come.

Implementing stricter opacity cutpoints for heavy-duty diesel vehicles and diesel buses will reduce emissions and improve air quality. Although the proposed cutpoints may result in some additional costs for vehicle owners and operators, those relatively small costs are reasonable when compared with the reduced impact on public health. In many cases, the increased

maintenance that will result from the proposed stricter cutpoints will generate a net savings because of the reduced amounts of fuel used by better-maintained engines.

Existing Opacity Cutpoints

The test procedures used in the Diesel Inspection Program to determine exhaust smoke opacity include the snap acceleration test, rolling acceleration test, and power brake test. Opacity is measured as the degree to which light is extinguished when smoke passes between a light source and a photoreceptor. Opacity is expressed as a percentage, where zero percent means that the light source is completely unobstructed, and 100 percent means that the light source is totally obscured.

The existing opacity cutpoints for diesel vehicles are set forth at N.J.A.C. 7:27-14.6, and are listed in Table 1 below. All emission standards, unless otherwise specified, are for peak smoke opacity to be determined in accordance with the snap acceleration test, rolling acceleration test, or power brake test methods. Peak opacity is the point at which the exhaust smoke is darkest during the test cycle. A well-maintained and properly tuned diesel engine should not emit smoke of any color in the exhaust, except for very short puffs of black smoke during acceleration, deceleration, or change of engine speed. Blue smoke, created by the intrusion and burning of engine lubricating oil into the combustion chamber, is an indication of mechanical malfunction, poor maintenance, or excessive wear. Engines emitting visible blue smoke for more than three consecutive seconds are in need of mechanical repair; thus, the existing prohibition for blue smoke as set forth in Table 1 below.

Table 1

EXISTING OPACITY CUTPOINTS

Engine Model Year	**Opacity Cutpoint**
Heavy-Duty Diesel Vehicles GVWR over 8,500 pounds	
1973 and older	70 percent
1974 or 1990	55 percent
1991 and newer	40 percent
No visible blue smoke >three consecutive seconds	
Diesel Bus and School Bus GVWR over 8,500 pounds	

1987 and older	40 percent
1988 and newer	30 percent
No visible blue smoke >three consecutive seconds	
Retrofitted* Diesel Buses GVWR over 8,500 pounds	
All model years	30 percent

On and after December 2, 2009, a heavy-duty diesel vehicle, tested using the snap acceleration smoke opacity test, the rolling acceleration smoke opacity test, or the power brake smoke opacity test set forth at N.J.A.C. 7:27B-4 shall not emit smoke in the exhaust emissions that exceeds the following opacity standards.

1. For model years 1990 and older, the level of peak smoke opacity shall not exceed 40 percent;
2. For model years 1991 through 1996, the level of peak smoke opacity shall not exceed 30 percent; and
3. For model years 1997 and newer, the level of peak smoke opacity shall not exceed 20 percent.

How to Read the Emission Report

The first 3 Opacity tests are Purging Tests labeled PSAT 1-3 they are calibrations of the truck to the emission equipment.

PSPREAD: is the difference from the highest purge number to the lowest purge number.

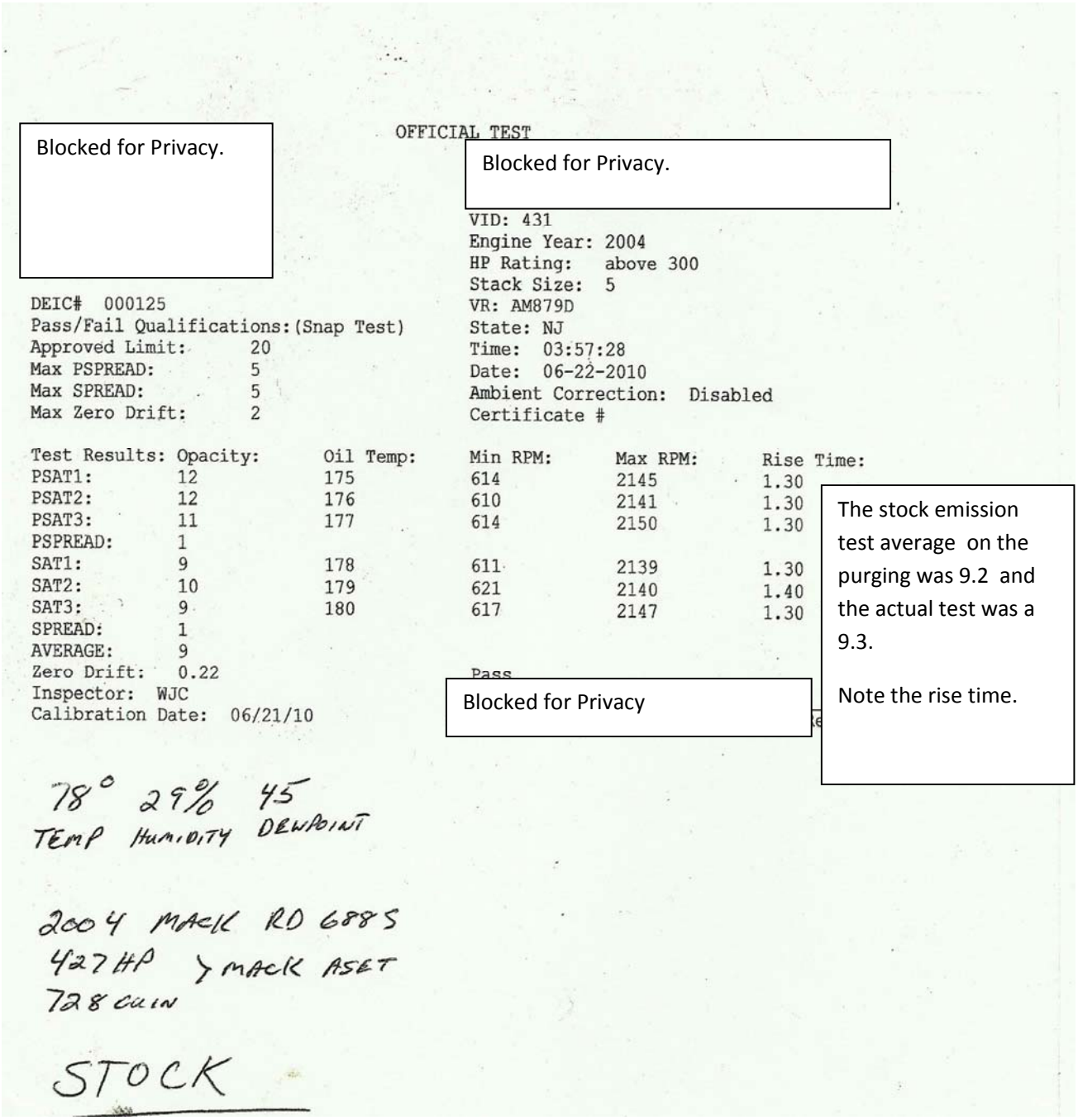
SAT1- SAT3: are the actual emission test numbers that are used .

SPREAD: again the highest to lowest difference in actual test this time.

AVERAGE: the average of the three numbers.

RISE TIME: the time it takes for the vehicle to go from its Minimum idle RPM to its Maximum RPM set-point

Zero Drift: is the amount of smoke left behind after the vehicle shuts off this number can vary based upon how quickly the vehicle was shut down after being revved up.



Blocked for Privacy.

OFFICIAL TEST

Blocked for Privacy.

VID: 431
Engine Year: 2004
HP Rating: above 300
Stack Size: 5
VR: AM879D
State: NJ
Time: 03:57:28
Date: 06-22-2010
Ambient Correction: Disabled
Certificate #

DEIC# 000125
Pass/Fail Qualifications: (Snap Test)
Approved Limit: 20
Max PSPREAD: 5
Max SPREAD: 5
Max Zero Drift: 2

Test Results:	Opacity:	Oil Temp:	Min RPM:	Max RPM:	Rise Time:
PSAT1:	12	175	614	2145	1.30
PSAT2:	12	176	610	2141	1.30
PSAT3:	11	177	614	2150	1.30
PSPREAD:	1				
SAT1:	9	178	611	2139	1.30
SAT2:	10	179	621	2140	1.40
SAT3:	9	180	617	2147	1.30
SPREAD:	1				
AVERAGE:	9				

Zero Drift: 0.22
Inspector: WJC
Calibration Date: 06/21/10

Pass

Blocked for Privacy

The stock emission test average on the purging was 9.2 and the actual test was a 9.3.

Note the rise time.

78° 29% 45
TEMP HUMIDITY DEWPOINT

2004 MACK RD 688S
427 HP } MACK ASET
728 CU IN

STOCK

Blocked for Privacy.

OFFICIAL TEST

Blocked for Privacy.

VID: 431
Engine Year: 2004
HP Rating: above 300
Stack Size: 5
VR: AM879D
State: NJ
Time: 02:21:22
Date: 06-25-2010
Ambient Correction: Disabled
Certificate #

DEIC# 000125
Pass/Fail Qualifications: (Snap Test)
Approved Limit: 20
Max PSPREAD: 5
Max SPREAD: 5
Max Zero Drift: 2

Test Results:	Opacity:	Oil Temp:	Min RPM:	Max RPM:	Rise Time:
PSAT1:	10	186	618	2153	1.20
PSAT2:	9	186	621	2147	1.30
PSAT3:	10	186	624	2149	1.30
PSPREAD:	1				
SAT1:	9	186	620	2149	1.30
SAT2:	9	187	619	2149	1.30
SAT3:	9	187	621	2146	1.20
SPREAD:	0				
AVERAGE:	9				

Average of 9 after install and vehicle running for 1 hour.

Zero Drift: 0.15
Pass
Inspector: WJC
Calibration Date: 06/21/10

Blocked for Privacy.

77° 29% 44
Temp Humidity Dewpoint

2004 MACK RD 6885
427 HP
728 CU IN > MACK ASET

After CAL-CAT Install running for 1 hour before test

Blocked for Privacy.

OFFICIAL TEST

Blocked for Privacy.

VID: 431
Engine Year: 2004
HP Rating: above 300
Stack Size: 5
VR: AM879D
State: NJ
Time: 04:59:05
Date: 07-09-2010
Ambient Correction: Disabled
Certificate #

DEIC# 000125
Pass/Fail Qualifications: (Snap Test)
Approved Limit: 20
Max PSPREAD: 5
Max SPREAD: 5
Max Zero Drift: 2

Test Results:	Opacity:	Oil Temp:	Min RPM:	Max RPM:	Rise Time:	
PSAT1:	7	174	632	2154	1.30	MT
PSAT2:	7	174	617	2144	1.30	MT
PSAT3:	8	175	615	2147	1.20	MT
PSPREAD:	1					
SAT1:	8	176	618	2148	1.20	MT
SAT2:	9	176	616	2150	1.30	MT
SAT3:	8	177	618	2149	1.30	MT
SPREAD:	1					
AVERAGE:	8					
Zero Drift:	0.52					
Inspector:	WJC					
Calibration Date:	07/09/10					

Blocked for Privacy.

Purging has dropped as well as the actual test 11% after running 2 weeks

82° 29% 49

270 761 mi.

W/ CALCAT 2WEEKS LATER

OFFICIAL TEST

Blocked for Privacy

38

Blocked for Privacy

VID: 431
Engine Year: 2004
HP Rating: above 300
Stack Size: 5
VR: AM879D
State: NJ
Time: 12:54:28
Date: 07-15-2010
Ambient Correction: Disabled
Certificate # H663009

DEIC# 000125
Pass/Fail Qualifications: (Snap Test)
Approved Limit: 20
Max PSPREAD: 5
Max SPREAD: 5
Max Zero Drift: 2

Test Results:	Opacity:	Oil Temp:	Min RPM:	Max RPM:	Rise Time:
PSAT1:	8	187	615	2135	1.20
PSAT2:	8	187	612	2140	1.20
PSAT3:	7	187	617	2140	1.20
PSPREAD:	1				
SAT1:	8	187	618	2130	1.30
SAT2:	7	188	615	2142	1.20
SAT3:	6	188	618	2132	1.20
SPREAD:	2				
AVERAGE:	7				

Zero Drift: 0.08
Inspector: WJC
Calibration Date: 07/09/10

Blocked for Privacy.

Note the drop in emissions in both the Purging calibration and the actual test. For an average of 7 which is 25% less than the Stock Average of 9.3. Also note the consistent rise time of 1.20 a full tenth of a second better for 10% indicating increased performance.

85°29% 52
27/227

W/ CAL-CAT 3 WEEKS After Install

Fuel Efficiency Report

Through better combustion and an increased torque curve, fuel efficiency should also increase. While the Cal-Cat was designed for increased engine performance, one of the other positive side effects of the increased combustion performance and power, in addition to emission reduction has been an increase in fuel efficiency. Fuel efficiency is dependent on many variables such as, efficiency of the original vehicle, condition of the vehicle, maintenance of the vehicle, weather conditions, quality of the fuel, vehicle load, accessories being used, as well as how the vehicles is driven. The Cal-Cat has also shown a marked increase in fuel efficiency of diesel engines. As stated previously the Cal-Cat enhances combustion making a more usable torque curve at lower RPM which delivers better fuel efficiency, especially if the vehicle is driven normally. Most vehicles that have Cal-Cats installed do not lose fuel efficiency being driven harder than normal which still is an overall net gain. The table below is from the same test vehicle used in the emission testing, the work cycle comparison shows a 29% increase in fuel efficiency. Overall fuel efficiency has improved from 22-29% depending on the varying workload of the vehicle (up to 80,000 pound loads)

Mack Tri-Axle Dump Truck GVW 80,000

Engine Year: 2004 Mack ASET

HP Rating: 427 HP

Engine CID: 728

Stock Un-modified

Truck	Date	Gallon Quantity	Odometer	Miles	MPG
431	6/01/10	26.39	0266595	0110	4.2
431	6/02/10	31.61	0266706	0110	3.5
431	6/03/10	25.86	0266800	0094	3.6
431	6/04/10	30.76	0266922	0122	4.0
				AVG MPG:	3.825

Modified Cal-Cat					
Truck	**Date**	**Gallon Quantity**	**Odometer**	**Miles**	**MPG**
431	7/07/10	77.09	0270065	0363	4.7
431	7/08/10	74.91	0270429	0364	4.9
431	7/09/10	68.64	0270761	0332	4.8
431	7/12/10	42.90	0270994	0233	5.4
				AVG MPG:	4.95

Total Average Mileage Increase is 29% for these work cycles

In Summary

The Cal-Cat has shown marked improvement in emission reduction, engine performance, and fuel efficiency. This product has the potential to help mitigate many of today's issues with diesel powered vehicles in emission output and the current systems in place that are mandated to deal with these issues. It also has the potential to help with power lag, fuel efficiency and savings in the maintenance associated with these vehicles. The Panther Performance Technology R&D Team has learned a great deal about diesel engines from this study which is still on-going and will continue indefinitely. Through our findings additional advancements may have been made to the proprietary catalyst blends and ratios used in the diesel units and are being tested to get increased results across the board. We look forward to bringing additional research data and findings as they develop.