Independent Field and Laboratory Tests of the Liberator™ brand Exhaust System

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Introduction

The Liberator™ brand Exhaust System presents a new, patented technology for diesel power applications, such as heavy duty trucks, off-road equipment, marine applications, rail power and stationary generators. The Liberator Exhaust System is a direct OEM or aftermarket muffler replacement that claims improved fuel economy, reduced noise, and higher torque and horsepower. The claims are due to the internal design of the exhaust system which effectively reduces engine backpressure while simultaneously dampening exhaust noise.

The theoretical underpinnings of the Liberator Exhaust System derive from the principle of destructive interference noise cancellation. Conventional noise reduction systems utilize a common series of baffles, supplemented by screens and various loads of fiber packing. These materials combine to form resistance to the free flow of air through the exhaust system. This resistance, in turn, causes significant backpressure which affects engine performance and functionality, but such limitations have been accepted as a necessary limitation in order to achieve effective noise dampening.

The design of the Liberator Exhaust System does not induce backpressure and, therefore, not only achieves excellent noise reduction, but higher overall power train efficiency with the subsequent benefits of more power, more torque, reduced fuel consumption, lower engine wear. Furthermore, in specific applications, the Liberator Exhaust System provides higher turbocharger boost, lower turbocharger lag, and less upshifting and downshifting.

Oakland University Field Testing

Oakland University's Product Development and Manufacturing Center (PDMC), located in Rochester, Michigan, was requested by Liberator Technologies, LLC to conduct a scientifically controlled field study to verify or disprove the efficiency gains engendered by the Liberator Exhaust System. The PDMC is home to the Truck Logistic and Technology Research Program which serves the transportation industry.

The field test consisted of a three-week baseline effort to document performance of four Class 8 trucks without the Liberator Exhaust System. The trucks were part of the DaimlerChrysler Transport fleet, an in-house carrier supplying automotive parts between manufacturing facilities. Following this baseline test, Liberator Exhaust Systems were installed on each truck and five separate mileage runs were conducted on each vehicle over the next four weeks.

The results of this independent test demonstrated that the Liberator Exhaust System reduced fuel consumption ranging from 0.37 miles per gallon to 0.78 miles per gallon.

Variables not controlled during testing were payload, ambient temperature, route, driving style, speed and vehicle configuration. Payload and temperatures changes were recorded and both increased during Liberator Exhaust System testing. Payload increases would normally penalize fuel consumption, and thus lend further support to the fuel mileage improvement results recorded.

Table 1 shows the performance data from the baseline test using the existing mufflers mounted on the trucks. Average fuel mileage ranged from 6.45 mpg to 6.90 mpg.

Table 2 shows the performance data from the tests run with the Liberator Exhaust System replacing the original mufflers.

Average fuel economy has now increased to a range of 7.20 mpg to 7.60 mpg.

Table 1 - Baseline Test Mileage

	Mileage (mpg) by Truck ID No.			
Test Date	**#1930**	**#1947**	**#1958**	**#1960**
May 11, 2005	6.95	6.87	6.63	6.47
May 18, 2005	6.74	6.88	6.19	6.75
May 25, 2005	6.74	6.89	6.25	6.75
June 1, 2005	6.97	6.97	6.72	6.65
w/o Liberator Exhaust (avg) =	**6.85**	**6.90**	**6.45**	**6.66**

Table 2 - Test Mileage with Liberator Exhaust System

	Mileage (mpg) by Truck ID No.			
Test Date	**#1930**	**#1947**	**#1958**	**#1960**
June 8, 2005	7.00	7.50	7.37	7.07
June 15, 2005	7.32	7.48	7.69	7.17
June 22, 2005	7.34	7.51	7.00	7.17
June 29, 2005	7.26	7.62	7.03	7.36
July 5, 2005	7.19	7.91	7.06	7.21
w/ Liberator Exhaust (avg) =	**7.22**	**7.60**	**7.23**	**7.20**

Table 3 highlights the mileage improvement when using the Liberator Exhaust System, shown in both mpg gain and percent improvement.

Table 3 - Mileage Improvement

	Mileage (mpg) by Truck ID No.			
	#1930	**#1947**	**#1958**	**#1960**
Orig config (avg mpg)	6.85	6.90	6.45	6.66
w/ Liberator (avg mpg)	7.22	7.60	7.23	7.20
MPG Improvement	**0.37**	**0.70**	**0.78**	**0.54**
% MPG Improvement	**5.43%**	**10.16%**	**12.14%**	**8.13%**

The on-road field tests conducted by Oakland University clearly demonstrated the fuel economy gains imparted by using the Liberator Exhaust System

Owens Community College Laboratory Testing

Owens Community College Transportation Technologies Department located in Toledo, Ohio was requested by Liberator Technologies, LLC to conduct laboratory tests on exhaust noise. The purpose of the test was to gather data on the Liberator Exhaust System in comparison to two well-known competitor products, Walker's Mega-Flow™ muffler and Donaldson's Silent Partner™ muffler.

The test program was conducted on a powertrain configuration in a no-load operating condition. Instrumentation was installed on the vehicle in order to determine comparative exhaust air flow, comparative exhaust backpressure, and noise cancellation performance. The test data was collected at engine speed values ranging from 600 RPM (approximately idle speed) to 1,200 RPM (approximately low engine operation). As a side note, the typical at-speed cruising RPM range for the vehicle's engine would be 1,500 to 1,700.

Test results demonstrated the Liberator Exhaust System had the lowest top-of-cab noise and the lowest in-cab noise. Test results also demonstrated the Liberator Exhaust System had the lowest backpressure.

Table 4 highlights the test data at both 600 and 1,200 RPM for the Liberator Exhaust System and two competitor products.

Table 4 - Exhaust Noise Comparison

	Liberator Exhaust System	**Walker Mega-Flow**	**Donaldson Silent Partner**
600 RPM (Idle)			
Top-of-Cab Noise	79.5	86.0	81.0
In-Cab Noise	61.8	63.0	63.3
1200 RPM (Low Op)			
Top-of-Cab Noise	84.5	95.0	90.3
In-Cab Noise	64.5	67.8	67.0

Test results measured in decibels (dB)

It is important to recognize that sound measurements in decibels (dB) is a measure of sound power (or sound pressure level), which is a logarithmic scale. Thus, an increase in ten decibels corresponds to a ten times increase in sound. In an attempt to show the relative exhaust noise difference between the Liberator Exhaust System and

the two competitor products, Table 5 shows a relative noise comparison.

Table 5 - Relative Noise Comparison

	Liberator Exhaust System	Walker Mega-Flow	Donaldson Silent Partner
600 RPM (Idle)			
Top-of-Cab Noise	79.5 dB	~4.5x Louder	~1.4x Louder
In-Cab Noise	61.8 dB	~1.3x Louder	~1.4x Louder
1200 RPM (Low Op)			
Top-of-Cab Noise	84.5 dB	~11.1x Louder	~3.9x Louder
In-Cab Noise	64.5 dB	~2.1x Louder	~1.9x Louder

Using this relative noise comparison demonstrates the competitive products range from 1.3 times louder to 11.1 times louder than the Liberator Exhaust System.

Tests were also conducted on engine backpressure. Pressure readings were taken at the muffler inlet. The backpressure forces generated at this intersection of muffler and powertrain system have a direct and measurable effect on engine performance, horsepower and, most importantly, fuel economy.

Figure 1 shows the backpressure readings at 1,200 RPM engine speed for the Liberator Exhaust System compared to the two competitors. The Liberator Exhaust System had 19.4% lower backpressure than the Walker Mega-Flow muffler and 22.9% lower backpressure than the Donaldson Silent Partner at 1200 RPM engine speed.

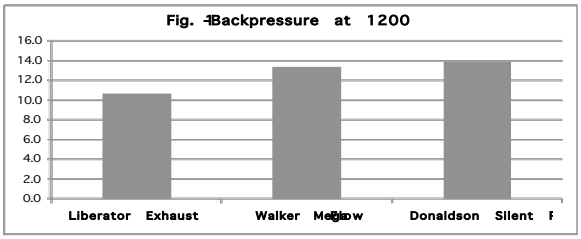
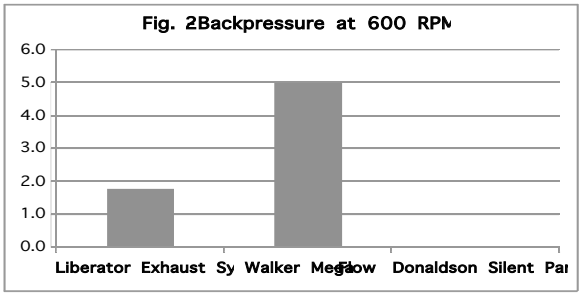


Figure 2 shows the backpressure readings at 600 RPM engine speed for the Liberator Exhaust System compared to the two competitors. Figure 2, however, omits data for Donaldson's Silent Partner muffler because the data was so excessive it could not be comparably measured – its performance was so poor it was outside the test limit range. The measurable results showed the Liberator Exhaust System was 64.0% lower backpressure at 600 RPM (idle) than the Walker Mega-Flow muffler.



Summary

Independent, on-road field testing by Oakland University confirms improved fuel economy using the Liberator Exhaust System when compared to the existing muffler.

Independent laboratory testing by Owens Community College demonstrates the Liberator Exhaust System has lower top-of-cab exhaust noise, lower in-cab exhaust noise, and reduced backpressure compared to the Walker Mega-Flow muffler and the Donaldson Silent Partner muffler.