Olson-ECOlogic
Engine Testing Laboratories, LLC

FINAL SUMMARY REPORT

Emission and Fuel Consumption Testing Of the Rentar In-Line Fuel Catalyst After 100 hours of Chassis Dynamometer Operation

Cummins Model N-14 Diesel Engine Powered Peterbuilt Tractor

Conducted for
Rentar Environmental Solutions, Inc.
11586 Pierson Road
West Palm Beach, FL 33414

November and December, 2003

By

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Executive Summary:

A Cummins model N-14 diesel engine powered Peterbuilt tractor with more than a million miles of over-the-road commercial operation was used to test the emission control and fuel economy effects of a commercial Rentar in-line fuel catalyst. All performance testing and mileage accumulation was done on a chassis dynamometer inside the environmentally controlled facility of Olson-ECOlogic Engine Testing Laboratories, LLC. Three separate and distinct testing sequences were used in multiples to measure exhaust emissions and fuel economy. Baseline data were first accumulated with California specification No. 2 diesel fuel. The Rentar In-Line Fuel Catalyst was then installed and the vehicle was operated for 100 hours using a typical driving pattern on the chassis dynamometer. Periodic measurements were made of the emissions and fuel economy over the 100-hour testing period by exactly the same testing protocols and with the same test fuel as used for the baseline measurements. During all testing cycles continuous and composite bag measurements were made of exhaust emissions including hydrocarbons (THC), carbon monoxide (CO), carbon dioxide (CO_2), oxides of nitrogen (NOx) and particulates (PM). Fuel consumption for each cycle was calculated by the standard carbon balance method. The sampling protocols and subsequent data for the particulate measurements is the subject of a separate report.

The three test cycles were selected to be representative of significantly different engine operating modes to provide a broad base of performance data since different operating modes are known to result in different levels and different species of exhaust emissions. The UDDS-HD cycle was a basis for the development of the FTP Transient engine dynamometer cycle. The NYCB cycle was developed to simulate typical stop and go driving as could be expected from a New York City Bus. Finally, the steady-state 50 MPH test cycle simulates steady state driving conditions as might be expected on the freeway. Significantly different baseline emissions result from these three cycles and it can be expected that different performance results may be expected when the Rentar in-line fuel catalyst is operating.

The emission and fuel consumption data are summarized in the following Summary Table No. 1. The data averages are based on multiple tests by the same test protocol in all cases. Detailed data for all test cycles and all tests are provided in Tables 2-6 inclusive.

state 50 MPH test cycle simulates steady state driving conditions as might be expected on the freeway. All test cycles were conducted after the vehicle had been operated to a warmed up equilibrium condition. Significantly different baseline emissions result from these three cycles and it can be expected that different performance results may be expected when the Rentar in-line fuel catalyst is operating. The UDDS-HD test cycle and NYCB cycles are graphically pictured in the Appendix. The steady-state 50 MPH cycle simply involved operating the vehicle after warming up to an equilibrium condition at a steady 50 miles per hour. Vehicle inertia and rear wheel horsepower settings were different for each of the three test cycles as follows:

Test Cycle	Vehicle Inertia Setting Pounds	Rear Wheel HP Setting at 50 MPH
UDDS-HD	8875	40
NYCB	5000	40
Steady-State 50 MPH	8875	20

Test Results:

A summary of all the test results is provided in Table 1 (located after the Executive Summary). The detailed replicated data in each test sequence are provided in subsequent Tables 2, 3, 4, 5 and 6. Table 2 provides the baseline data and Tables 3, 4, 5 and 6 provide the data at 33, 67, 90 and 100 hours respectively.

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SUMMARY OF RESULTS

Table 1

Emission and Fuel Economy Improvement with the Rentar In-Line Fuel Catalyst
After 100 hours of Chassis Dynamometer Operation
Rentar Environmental Solutions, Inc.
Cummins N-14 Diesel Engine, California Specification No. 2 Diesel Fuel

	Grams per mile					Miles Per Gallon Fuel
	THC	CO	NOx	CO_2	PM	
UDDS-HD Test Cycle						
Avg of 6 cycles						
Baseline	0.868	1.827	11.854	1007.978	0.541	10.177
With Rentar Device	0.876	1.820	10.150	938.607	0.508	10.917
Improvement	**-0.9%**	**0.4%**	**14.4%**	**6.9%**	**6.1%**	**7.3%**
New York City Bus Cycle						
Avg of 6 cycles						
Baseline	1.728	3.964	18.718	1567.833	0.597	6.555
With Rentar Device	2.172	3.780	14.869	1410.703	0.577	7.233
(Only 3 cycles for the Rentar baseline PM data)						
Improvement	**-25.7%**	**4.6%**	**20.6%**	**10.0%**	**3.4%**	**10.3%**
Steady State Operation -- 50 MPH						
Avg of 6 cycles						
Baseline	0.266	0.901	7.432	611.860	0.277	16.848
With Rentar Device	0.308	0.896	6.249	577.270	0.251	17.800
(Only 3 cycles for the Rentar baseline PM data)						
Improvement	**-15.7%**	**0.6%**	**15.9%**	**5.7%**	**9.4%**	**5.7%**

Note: PM data were captured on one filter for three replicate tests in each case to assure enough sample for accurate measurement

Olson-ECOlogic
Engine Testing Laboratories, LLC

January 16, 2004

Mr. Joel Ratner
President/CEO
Rentar Environmental Solutions, Inc.
11586 Pierson Road
West Palm Beach, FL 33414

Re: NOx emissions and Fuel economy data with the Rentar in-line fuel catalyst

Dear Mr. Ratner:

This letter is in response to your request for the average NOx and fuel economy data from the emission tests we recently completed on a Cummins N-14 diesel engine with over a million odometer miles after normal operation with the Rentar in-line fuel catalyst for 100 hours. .

These data were obtained on the Olson-ECOlogic chassis dynamometer from triplicated data for three different test cycles. The averages represent a total of nine baseline tests and nine tests identical to the baseline tests after 100 hours of operation with the Rentar device installed. The overall averages were as follows:

	Baseline	After 100 hours of Rentar operation	Average % Improvement
NOx, grams per mile	12.67	10.43	17.7
Fuel economy, miles per gallon	11.19	11.98	7.1

Other significant reductions occurred in exhaust particulate matter too and we are in the process of completing the analyses of those data.

Sincerely,

Donel R. Olson
President

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Introduction

A project sponsored by Rentar Environmental Solutions, Inc. was conducted at the Olson-Ecologic Engine Testing Laboratory in Fullerton, California. The project objective was to measure the effect of a Rentar in-line-fuel catalyst on Particulate Matter (PM) in the exhaust when a Cummins N-14 Diesel engine was operated over typical test cycles.

Test Vehicle

The test vehicle is a 1994 Peterbuilt Model 377 Freightliner tractor powered by a Cummins N-14 Diesel engine (V.I.N. # RD355104). The tractor registered 1,062,760 miles on the odometer at the project beginning.

Test Fuel

The test fuel was a California specification No. 2 Diesel fuel (See Appendix).

Test Protocol

Particulate Matter (PM) samples were collected while operating the tractor on a chassis dynamometer over three testing cycles. They were Urban Dynamometer Driving Sequence – Heavy Duty cycle (UDDS – HD), New York City Bus cycle (NYCB), and 55 MPH steady state operation at 20 road load horsepower. The UDDS-HD and NYCB test protocols are described in the Code of Federal Regulations (CFR 40, 86). Triplicate PM samples were collected on a single filter to assure adequate sample mass for precision weighing and duplicate filter experiments were conducted for each testing cycle on the baseline. After completion of baseline testing the Rentar in-line fuel catalyst was installed exactly as specified by the Rentar representative. The test vehicle was operated over a typical driving pattern on the chassis dynamometer for 100 hours. PM samples when operating on the UDDS cycle were also collected at 33, 68 and 90 hours, respectively. The same three test cycles were performed at 100 hours and duplicate exhaust particulate samples were captured. The test protocols and data for the gaseous data and fuel economy measurements which were measured simultaneously with the PM measurements are described in a separate report.

Test Results

The PM results for the baseline and 100 hours are provided in Table 1. New York City Bus cycle and the Steady State cycle only show one set of baseline results because the sampling flow on those tests was the same as the 100 hours sampling flow. The results are the most representative. Table 2 provides the data at 33, 68, and 90 hours for the UDDS-HD cycle (only) respectively.

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TABLE 1
(Continued)

NYCB Transient Cycle

Baseline

Test Number	Grams per Mile PM
V5001633	
V5001634	0.597
V5001635	

100 Hours with Rentar Device

Test Number	Grams per Mile PM
V5001701	
V5001702	0.549
V5001703	
V5001716	
V5001717	0.605
V5001718	
Average	**0.577**

Reduction in PM after 100 hours	3.4 %

TABLE 1

Particulate Matter Data for Baseline and 100 Hours

Chassis Dynamometer Testing
Peterbuilt Freightliner Tractor Power by a Cummins N-14 Diesel Engine
California Specification NO. 2 Diesel Fuel

UDDS – HD Transient Cycle

Baseline

Test Number	Grams per Mile PM
V5001616	
V5001617	0.550
V5001618	
V5001627	
V5001628	0.532
V5001629	
Average	**0.541**

100 Hours with Rentar Device

Test Number	Grams per Mile PM
V5001690	
V5001691	0.462
V5001692	
V5001712	
V5001713	0.553
V5001714	
Average	**0.508**

Reduction in PM after 100 hours	6.1 %

TABLE 1
(Continued)

Steady-State 55 MPH

Baseline

Test Number	Grams per Mile PM
V5001630	
V5001631	0.277
V5001632	

100 Hours with Rentar Device

Test Number	Grams per Mile PM
V5001693	
V5001694	0.255
V5001695	
V5001704	
V5001705	0.247
V5001706	
Average	**0.251**

Reduction in PM after 100 hours	9.4 %

TABLE 1
(Continued)

NYCB Transient Cycle

Baseline

Test Number	Grams per Mile PM
V5001633	
V5001634	0.597
V5001635	

100 Hours with Rentar Device

Test Number	Grams per Mile PM
V5001701	
V5001702	0.549
V5001703	
V5001716	
V5001717	0.605
V5001718	
Average	**0.577**
Reduction in PM after 100 hours	3.4 %

TABLE 2

Particulate Matter data at 33, 68 and 90 hours with the Rentar device installed

Chassis Dynamometer Testing
Peterbuilt Freightliner Tractor Power by a Cummins N-14 Diesel Engine
California Specification NO.2 Diesel Fuel

UDDS – HD Transient Cycle

Test Hours	Test Number	Grams per Mile PM
33	V5001659	
	V5001660	0.545
	V5001661	
	V5001662	
	V5001663	0.552
	V5001664	
	Average	**0.549**
68	V5001666	
	V5001667	0.568
	V5001668	
	V5001669	
	V5001670	0.592
	V5001671	
	Average	**0.580**
90	V5001679	
	V5001680	0.588
	V5001681	

Emission Test Cycles

EPA New York City Cycle (NYCC)

Time-speed data points

The EPA NYCC test has been developed for chassis dynamometer testing of light-duty vehicles *(CFR 40, 86, App.I)*. The test simulates low speed urban driving with frequent stops.

The following are basic parameters of the cycle:

- Duration: 598 seconds
- Distance: 1.18 miles = 1.89 km km
- Average speed: 7.1 mi/h = 11.4 km/h
- Maximum speed: 27.7 mi/h = 44.6 km/h

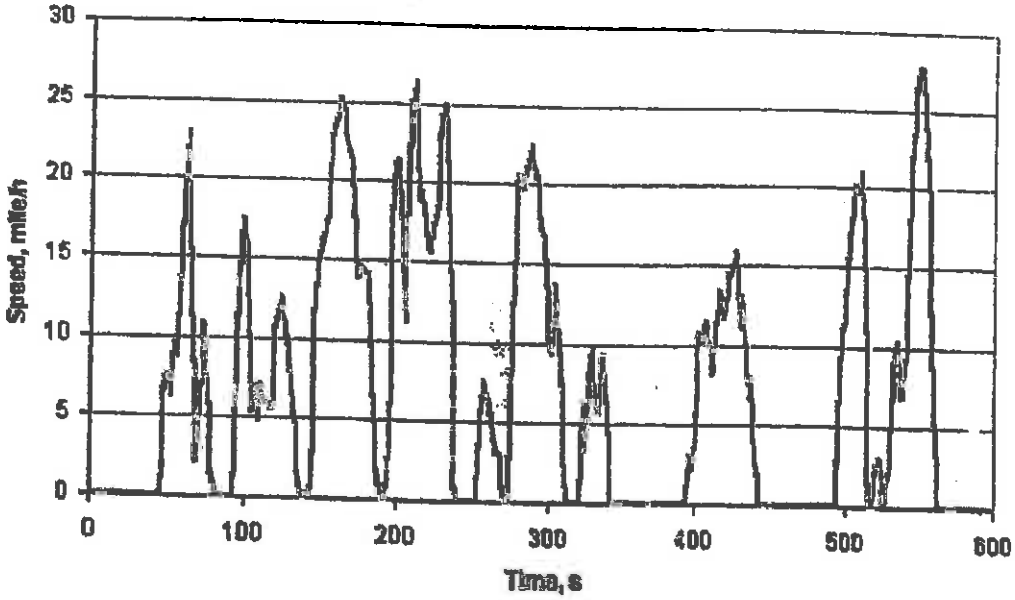

Figure 1. EPA NYCC Cycle