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**TEST REPORT**

**Effect of the Rentar In-Line Fuel Catalyst  
When Installed on a Cummins ISM 330 Engine  
That Powers a Penske Navistar-International Tractor**

**Emission and Fuel Consumption Testing When Operated  
Over the Urban Dynamometer Driving Sequence – Heavy-Duty  
In Accordance With The CARB/EPA Protocol**

**Conducted at the ECOlogic Emission Testing Laboratories  
Fullerton, California**

**February 11- 18, 2003**

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### **Introduction:**

This report summarizes the emission and fuel consumption data obtained when operating a Cummins ISM 330 diesel engine over the Urban Dynamometer Driving Sequence – Heavy-Duty (UDDS-HD) on a chassis dynamometer. Triplicate baseline data were first obtained while operating on No. 2 EPA certification (red dye) diesel fuel. An 8-inch Rentar in-line fuel catalyst was then installed as close to the fuel rail as possible and the Penske tractor was operated over a typical driving cycle for 50 hours at an average speed of 35.5 MPH. This mileage accumulation driving cycle consists of operating at road load conditions with speeds up to 55 mph. The specific driving cycle takes 1 hour and 40 minutes and is repeated 30 times to provide 50 hours of accumulation. It is described in the enclosed table. Finally, emissions and fuel consumption were again measured in triplicate tests using the same test fuel under exactly the same conditions as used in the baseline testing.

### **Test Vehicle:**

The test vehicle was a Penske rental tractor built by International and powered by a Cummins ISM 330 diesel engine (I.D. # 34989716). The tractor uses a single rear axel and is designed to pull loads in excess of 20,000 pounds. The six-cylinder diesel engine is rated at 330 HP in this application. The tractor registered 127475 miles on the odometer at the beginning of testing and 129356 miles at the conclusion.

### **Test Fuel:**

The test fuel was provided by Dion and Sons of California and meets EPA specifications for a No. 2 diesel fuel. This fuel is the standard for tax-free off-road and laboratory use. It includes red dye to assure non-road use only.

### **Test Protocol:**

The UDDS-HD test protocol is provided in the Code of Federal Regulations (*CFR 40, 86, App.1*) and is specified by CARB for testing of diesel engine driven vehicles. The testing cycle is illustrated in the enclosed figure. Each test consists of operating the vehicle for 1060 seconds over a typical Urban Driving Sequence with a maximum speed of 58 MPH and an average speed of 18.86 MPH. Inertia loading is provided by use of mechanical flywheels and power absorption is accomplished with a standard Clayton water brake dynamometer. For this test work inertia flywheels of 8,875 pounds were used (for acceleration and deceleration) and power was set at 50 MPH to be 22 HP to simulate steady-state power requirements for all speeds. It was estimated that this power and inertia is equivalent to the average load usually pulled by a tractor of this size.

### **Results:**

The emission and fuel consumption results are tabulated in the attached table. The triplicate emission and fuel consumption average results are summarized as follows:

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**Rentar 8-inch Fuel Catalyst installed on a Cummins  
ISM 330 Diesel Engine in a Penske Rental Truck  
(International)**

**BASELINE DATA (No.2 Red Dye Diesel Fuel):**

Test no.	HC	GRAMS/MILE			CO <sub>2</sub>	MPG
		CO	NO <sub>x</sub>			
#2	1.735	4.479	7.968	843.40	12.09	
#3	1.827	4.831	8.013	839.67	12.13	
#4	<u>1.490</u>	<u>4.130</u>	<u>7.829</u>	<u>820.90</u>	<u>12.43</u>	
Avg:	<u>1.684</u> =====	<u>4.643</u> =====	<u>7.937</u> =====	<u>835.66</u> =====	<u>12.22</u> =====	

**DEVICE DATA (After 50 hours of Engine Operation):**

Test no.	HC	CO	NO <sub>x</sub>	CO <sub>2</sub>	MPG
#1a	1.285	4.063	7.657	802.30	12.73
#2a	1.669	3.578	7.616	792.57	12.88
#3a	<u>1.646</u>	<u>3.532</u>	<u>7.459</u>	<u>790.20</u>	<u>12.92</u>
Avg:	<u>1.438</u> =====	<u>3.724</u> =====	<u>7.577</u> =====	<u>795.02</u> =====	<u>12.84</u> =====

**Improvement %**

**-14.6%      -19.8%      -4.5%      -4.9%      +5.1%**

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**Emission and Fuel Consumption Testing When Operated  
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**Conducted at the ECOlogic Emission Testing Laboratories  
Fullerton, California**

**March, 2003**



**Introduction:**

This report summarizes the emission and fuel consumption data obtained when operating a Cummins ISM 330 diesel engine over the Urban Dynamometer Driving Sequence – Heavy-Duty (UDDS-HD) on a chassis dynamometer. Triplicate baseline data were first obtained while operating on No. 2 EPA certification (red dye) diesel fuel. The standard 8-inch Rentar in-line fuel catalyst was then installed as close to the fuel rail as possible and the Penske tractor was operated over a typical driving cycle for 50 hours at an average speed of 35.5 MPH. This mileage accumulation driving cycle consists of operating at road load conditions with speeds up to 55 mph. The specific driving cycle takes 1 hour and 40 minutes and is repeated 30 times to provide 50 hours of accumulation. It is described in the enclosed table. Emissions and fuel consumption were again measured in triplicate tests using the same test fuel under exactly the same conditions as used in the baseline testing to define the emission and fuel consumption effect of the Rentar device.

**Test Vehicle:**

The test vehicle was a Penske rental tractor built by Freightliner and powered by a Cummins ISM 330 diesel engine (V.I.N. # 2HSCEAHR21CO93080). The tractor uses a single rear axel and is designed to pull loads in excess of 20,000 pounds. The six-cylinder diesel engine is rated at 330 HP in this application. The tractor registered 100,970 miles on the odometer at the beginning of testing and 102,804 miles at the conclusion.

**Test Fuel:**

The test fuel was provided by Dion and Sons and meets EPA specifications for a No. 2 diesel fuel. This fuel is the standard for tax-free off-road and laboratory use. It includes red dye to assure non-road use only.

**Test Protocol:**

The UDDS-HD test protocol is provided in the Code of Federal Regulations (*CFR 40, 86, App.1*) and is specified by CARB for testing of diesel engine driven vehicles. The testing cycle is illustrated in the enclosed figure. Each test consists of operating the vehicle for 1060 seconds over a typical Urban Driving Sequence with a maximum speed of 58 MPH and an average speed of 18.86 MPH. Inertia loading is provided by use of mechanical flywheels and power absorption is accomplished with a standard Clayton water brake dynamometer. For this test work inertia flywheels of 8,875 pounds were used (for acceleration and deceleration) and power was set at 50 MPH to be 22 HP to simulate steady-state power requirements for all speeds. It was estimated that this power and inertia is equivalent to the average load usually pulled by a tractor of this size. After each transient cycle the truck was operated at 40 MPH steady state and all emissions were again measured at this condition.

**Results:**

The emission and fuel consumption results are tabulated in the attached table. The triplicate emission and fuel consumption average results are summarized as follows:

UDDS-HD Transient Cycle Data:

	<u>Grams per mile</u>				<u>Grams</u>	<u>Miles/gallon</u>
	<u>HC</u>	<u>CO</u>	<u>NOx</u>	<u>CO<sub>2</sub></u>	<u>PM</u>	
Baseline data:	1.394	2.469	6.590	896.95	0.0021	11.43
After 50 hours of operation with the Rentar device	1.493	2.402	6.200	895.48	0.0021	11.45
Percent Change, %	+7.1	-2.7	-5.9	nil	-0-	nil

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**Table 1**  
**Data Summary**  
 Rentar 8-inch Fuel Catalyst Installed on a Cummins ISM 330  
 Diesel Engine in a Penske Rental Truck (International)

**UDDS-HD Transient Cycle**

**Baseline Data (No.2 Red Dye Diesel Fuel)**

Test no.	Grams per Mile				Grams	Miles/Gallon
	THC	CO	NOx	CO2	PM	
1.	1.389	2.547	6.760	906.44	0.0023	11.31
2.	1.360	2.424	6.583	894.17	0.0019	11.47
3.	<u>1.434</u>	<u>2.436</u>	<u>6.426</u>	<u>890.23</u>	<u>0.0020</u>	<u>11.51</u>
<b>Average</b>	<b>1.394</b>	<b>2.469</b>	<b>6.590</b>	<b>896.95</b>	<b>0.0021</b>	<b>11.43</b>

**Device Data (After 50 hours of engine operation)**

Test no.	Grams per Mile				Grams	Miles/Gallon
	THC	CO	NOx	CO2	PM	
1a.	1.464	2.409	6.336	903.91	0.0017	11.34
2a.	1.510	2.413	6.259	905.85	0.0024	11.31
3a.	<u>1.504</u>	<u>2.383</u>	<u>6.006</u>	<u>876.67</u>	<u>0.0021</u>	<u>11.69</u>
<b>Average</b>	<b>1.493</b>	<b>2.402</b>	<b>6.200</b>	<b>895.48</b>	<b>0.0021</b>	<b>11.45</b>
<b>Change, %</b>	<b>+7.1</b>	<b>-2.7</b>	<b>-5.9</b>	<b>nil</b>	<b>-0-</b>	<b>nil</b>

**Steady-State 40 MPH**

**Baseline Data (No. 2 red Dye Diesel Fuel)**

Test No.	Grams per Mile				Grams	Miles/Gallon
	THC	CO	NOx	CO2	PM	
1.	0.861	1.642	5.169	617.58	0.0009	16.64
2.	0.857	1.678	5.338	629.91	0.0011	16.30
3.	0.839	1.500	5.508	632.84	0.0007	16.23
<b>Average</b>	<b>0.852</b>	<b>1.606</b>	<b>5.340</b>	<b>626.77</b>	<b>0.0009</b>	<b>16.39</b>

**Device Data (After 50 hours of engine operation)**

Test No.	Grams per Mile				Grams	Miles/Gallon
	THC	CO	NOx	CO2	PM	
1a.	0.819	1.426	5.106	617.07	0.0007	16.63
2a.	0.814	1.424	4.943	607.16	0.0009	16.90
3a.	0.824	1.447	4.785	598.56	0.0011	17.14
<b>Average</b>	<b>0.819</b>	<b>1.432</b>	<b>4.945</b>	<b>607.60</b>	<b>0.0009</b>	<b>16.89</b>
<b>Change, %</b>	<b>-3.9</b>	<b>-10.8</b>	<b>-7.4</b>	<b>-3.1</b>	<b>-0-</b>	<b>+3.1</b>



Emission Test Report

Page two

40 MPH Steady State Data:

	<u>Grams per mile</u>				<u>Grams</u>	<u>Miles/Gallon</u>
	<u>HC</u>	<u>CO</u>	<u>NOx</u>	<u>CO<sub>2</sub></u>	<u>PM</u>	
Baseline data	0.852	1.606	5.340	626.77	0.009	16.39
After 50 hours Of operation with The Rentar Device	0.819	1.432	4.945	607.60	0.009	16.89
Percent change, %	-3.9	-10.8	-7.4	-3.1	-0-	+3.1

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