Emissions Reducing Benefits of the ECO-Systems Retrofit Device

FINAL REPORT

Texas Council on Environmental Technology (TCET)
Emissions Reducing Grant
Contract Number 02-R01-27G

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On behalf of
Emissions Technology of Texas, L.L.C.
For the
Texas Commission on Environmental Quality
New Technology, Research & Development Program
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Preface

This report is being submitted as required by Texas Commission on Environmental Quality (TCEQ) Contract Number 02-R01-27G. It was prepared by J. Wade Thomason II, President and Principal; J. Wade Thomason II Public Affairs on behalf of the grant recipient Emissions Technology of Texas, L.L.C.

Introduction

This is the final report for the TCET (Texas Council on Environmental Technology) grant funded project that was awarded in 2003 to Emissions Technology of Texas, L.L.C., distributor of the ECO-System (Emission Control Optimizer), a retrofit fuel line device designed to decrease tailpipe emissions. The purpose of the project was to test the ECO-System device for its effectiveness in reducing tailpipe emissions from gasoline engines, particularly nitrogen oxides and hydrocarbons, the two main components of ground level ozone. This was done in an EPA approved laboratory on a treadmill using an emissions gas analyzer and other equipment, as per EPA Federal Test Procedures (FTP). Test vehicles were targeted that research has shown are major emitters of these emissions among on-road vehicles in the Dallas-Ft. Worth and Houston-Galveston ozone nonattainment areas, which are also the largest metropolitan areas in Texas. The purpose of this strategy was to demonstrate the potential for the technology to reduce the contribution to ozone formation made by these high emitting vehicles, if it were to be deployed in sufficient magnitude in the two largest and worst ozone nonattainment areas in Texas.

The original intent of the testing was to use the data gathered to pursue EPA Verification. Receiving EPA Verification would qualify the technology for eligibility as a strategy to be used in the SIP (State Implementation Plan) for nonattainment areas and in the EAC (Early Action Compact) of near nonattainment areas opting for that plan.

History of the Project

The Texas Council on Environmental Technology (TCET) was created by the Texas Legislature in 2001 to promote the development of technology designed to improve air quality that could be deployed in areas of Texas that are not meeting federal air quality standards. The council came into being on September 1, 2001 and over the next year the structure for creating and implementing an environmental technology grant program was put into place. Subsequently, a request for proposals (RFP No. 02-R01) was issued in 2002 and a grant for $81,700 was awarded to Emissions Technology of Texas, L.L.C. However, approximately another year went by as TCET requested further information which was provided in correspondence dated July 24, 2003, July 31, 2003, August 8, 2003, and August 31, 2003. Finally, a grant agreement was signed that provided an eight month contract period beginning on August 1, 2003 and terminating on March 30, 2004. By this point in time (2003), the Texas Legislature was again in session and at the behest of Governor Perry, TCET was dissolved and its responsibilities were transferred to the Texas Commission on Environmental Quality (TCEQ), where it became the New Technology Research and Development (NTRD) program.

Due to the transition of the program to a new home and issues involving the grant recipient, Emissions Technology of Texas, L.L.C., and their consultant, Good Company Associates, grant activities were not initiated and no funds were expended. Rather than lose the grant, in February 2004, the grant recipient requested a six month extension of the grant contract. Two changes to the agreement were also requested. These were the transfer of project management responsibilities from Good Company Associates to J. Wade Thomason II Public Affairs and changing the emissions testing facility from Southwest Research Institute to Wallace Environmental Testing Laboratories, Inc. (WETL, Inc.). These requests were granted and a six month contract extension was initiated that began on April 1, 2004 and terminated on September 30, 2004. Due to their inability to complete all the tasks in the work plan, the grantee requested and received another contract extension of four months beginning on October 1, 2004 and ending on January 31, 2005.

Description of the Technology

The housing of the ECO-System retrofit fuel line device consists of a steel tube with threaded fittings on each end. The fittings are used to install the unit on the fuel line after the fuel filter and before the carburetor or fuel injectors. The core of the unit is composed of a series of copper discs that are punched out and bent in a concave direction. These copper discs are packed tightly within the steel tube.

As the fuel passes through the device, it is agitated. This creates a reaction that breaks up the hydrocarbon bonds in the fuel and increases its volatility or Reid Vapor Pressure (RFP), as well as increasing the vaporization of the fuel by the injectors or carburetor. This vaporization causes the fuel to combust more completely, resulting in a more uniform and even burn. Burning the fuel more completely reduces emissions of HC and CO, while burning the fuel more evenly reduces the NOx emissions. By causing the fuel to burn more completely, there are less evaporative emissions; more power is derived from the fuel which causes an increase in performance, and fuel economy is realized as less fuel is needed to do the same job.

Goals of the Project

The original primary goal of the project was to use the test data for verification testing. However, over time it became apparent that this was not going to be feasible, for a number of reasons. Almost two years passed from the time the grant application was approved and the grant activities were finally initiated. Cost estimates used in the grant proposal were dated by the time the grant activities actually took place. Significant changes also took place over that time period including the government entity responsible for the program and the project management. Over this period of time and with significant personnel changes, things are sometimes lost due to a lack of continuity and institutional memory. Nonetheless, the original intent of demonstrating the effectiveness of the technology in reducing ozone causing tailpipe pollutants remained. Therefore, it was determined that the testing would be conducted at WETL, Inc. and the test results would be used to determine the viability of the technology to pursue EPA Verification, not to actually conduct verification testing, which was to have taken place at Southwest Research Institute in San Antonio.

In terms of demonstrating its ability to reduce regulated tailpipe emissions, the ECO-System device performed well, as was demonstrated by the test results. WETL, Inc. stated in their FINAL REPORT that **"the effect of adding the Eco-2 Vapor Pressure Enhancer was found in all instances to reduce most regulated emissions."** These emissions test results, fuel economy tests, and other aspects of the technology that may not be represented well in the test results, will be discussed later in this report. Whether the technology will eventually be subjected to verification testing will also be discussed in the *Conclusions and Recommendations* section of this report.

Summary of the Project Activities

Three contractors were responsible for completion of the project activities. Their areas of responsibility were as follows:

CONTRACTOR	RESPONSIBILITIES
1. J. Wade Thomason II Public Affairs	Project management & liaison to TCEQ, Administrative duties including reporting requirements and financial affairs
2. Charles Edwin "Ed" Martin Jr.	Technical adviser on selection of test vehicles, test procedures and test results
3. Wallace Environmental Testing Laboratories, Inc	Test four selected vehicles for emissions and fuel economy in a laboratory setting following Federal Test Procedures (FTP) and reporting the test results to TCEQ

The grant recipient, Ben Talamantez with Emissions Technology of Texas, was also closely involved with the project. He provided several in-kind services. These included furnishing the ECO-System devices for the testing and providing expertise on installing them, as well as his personal expenses for traveling to Houston and time spent there, time away from his business, and other project associated costs.

Because the purpose of the project changed while it was already underway, some effort was made initially toward working with EPA/ETV at Research Triangle Institute to determine a prudent plan that would lead to verification. Once it was determined that the test data would not be considered for verification purposes, the tasks related to EPA involvement in the original Updated Scope of Work, Schedule, and Deliverables became obsolete. Therefore, during the process of receiving a second contract extension in October 2004, the Updated Scope of Work, Schedule, and Deliverables (2nd Contract Extension) was revised accordingly. Comments are provided under each item listed below to summarize activities and evaluate contractor's performance.

Updated Scope of Work, Schedule, and Deliverables (2nd Contract Extension)

To carry out the proposed project, Emissions Technology of Texas and/or its consultant will:

1. Contract with TCEQ for this project (April 1, 2004 or sooner).

A contract extension was granted and signed by TCEQ on March 30, 2004. A second contract extension was signed in September 2004 that extends the contract period until January 31, 2005.

2. Contract with J. Wade Thomason II, consultant, to manage the project and be TCEQ's primary contact throughout the project (April 1, 2004 or sooner).

J. Wade Thomason II Public Affairs was hired on April 1, 2004 and has been responsible for project management and administration, including acting as liaison for Emissions Technology of Texas to all involved parties, including TCEQ.

3. Begin dialogue with EPA/ETV Program at Research Triangle Institute to determine the most expeditious verification plan (April 1, 2004 or sooner).

Contact was made via telephone on April 8, 2004 with Mr. Drew Trenholm/EPA Environmental Technology Verification (ETV) program at Research Triangle Institute, Research Triangle Park, North Carolina. Verification issues were discussed as they pertained to Eco-System's pursuit of EPA Verification. A follow up letter and project information were sent for his perusal and comment on April 28, 2004. In discussions with EPA, it was determined that further testing beyond this project would be needed to pursue verification. This led to the conclusion that the testing done during the project will not be considered for verification purposes, but will be considered pre-verification testing to demonstrate the effectiveness of the technology and its potential for pursuing a verification plan.

4. In consultation with TCEQ, determine the appropriate testing design and protocol (April 15, 2004).

As part of granting the first contract extension, TCEQ approved the submitted testing plan, which had been developed during the original grant period and followed federal testing protocol. Southwest Research Institute and Wallace Laboratories concurred prior to the project that the testing plan met all requirements for Federal Test Procedures (FTP) and Highway Fuel Economy Tests (HFET).

5. Based on availability and cost effectiveness, designate an EPA approved emissions testing facility to conduct testing of the retrofit device, consistent with Federal Test Procedures (FTP). Wallace Laboratories of Houston is the first choice. (April 30, 2004)

Wallace Environmental Testing Laboratories, Inc. (WETL, Inc.) in Houston was approved by TCEQ as part of the contract extension. Wallace submitted a testing plan that was used as the basis for approval. Because of their requirement for payment prior to testing, payment of $54,000.00 was made and a contract was signed on June 15, 2004. Testing began in June and concluded at the end of July, 2004.

6. Determine through research, the best candidate vehicles for retrofit devices, based upon their contribution to the pollutants that form ground level ozone (NOx and HC) in the major Texas urban nonattainment areas. Confirm findings and conclusions with TCEQ. (April 30, 2004)

Ed Martin worked with the Mobile Source staff at TCEQ and analyzed data provided by them. Records of emissions testing conducted by his company in the Dallas-Ft.Worth area were also reviewed. Because of his involvement in the design of the Air Check Texas program, he has expertise in knowing which vehicles perform badly and why. During the first contract extension period, Wade Thomason and Ed Martin conducted a work session at Ed's office in Plano on April 30th. From that work session, they were able to cull down the candidate vehicles to the list presented during the May 6th conference call of the project team. After some further paring down from that list, they were able to choose the four vehicles to be tested from those available in the Port of Houston Authority motor pool. Ben Talamantez and Thomason physically inspected the vehicles at the POHA motor pool lot to ensure compliance with the established selection criteria. TCEQ was kept aware of developments as they occurred through progress reports submitted on a monthly basis, as well as phone calls and emails as needed.

7. Ed Martin will perform preliminary tests on the vehicles identified as best candidates for the retrofit devices, using a 5-gas analyzer and chassis dynamometer. (April 30, 2004)

These tests were performed in Plano on vehicles that fit the general profile criteria prior to selection of the actual test vehicles. These test data were used in determining which vehicles were chosen for testing.
Ed reviewed and approved the vehicles selected from the motor pool lot by Thomason and Talamantez.
He traveled to Houston on June 14th to examine the test vehicles prior to testing and confer with the project team, including the staff at Wallace Environmental Testing Laboratories.

8. Conduct initial vehicle testing. (Emissions Technology and/or consultant to be present at all times during testing.) (May 31, 2004)

Testing on the first vehicle (1999 V-6 3.9L Dodge Magnum Pick Up) began the week of June 14th and concluded the last week of June. A representative of Emissions Technology and/or the Project Manager was present at all times during the testing.

9. Review the preliminary results of the initial tests. Identify, if any, problems or unexpected issues that may arise. If adjustments need to be made to the testing procedure, those will only be made with approval from TCEQ, or the testing facility. (May 31, 2004)

Initial test results were examined and discussed by the grant recipient, consultants, and Wallace Laboratories staff. No significant changes were made to the testing procedures. Unexpected problems were encountered with the fuel system (fuel regulator in tank, no return fuel line) causing the volumetric fuel economy test to be very difficult to conduct and it was decided that it would not be done. None of the other vehicles had this type of fuel system, so it was not a problem for the rest of the testing.

10. Test the remainder of the designated vehicle types. (May 31, 2004)

The vehicle testing concluded on July 16, 2004.

11. Receive the lab report. (October 10, 2004)

The Final Report and Individual Vehicle Reports for each of the four test vehicles were submitted in hard copy form by WETL, Inc. to TCEQ in early October. The grant recipient was furnished with the same documentation.

12. Review the report and send a copy to TCEQ. (October 15, 2004)

TCEQ received hard copies of all the supporting testing documentation, in addition to the Final Report and Individual Vehicle Reports in October directly from Wallace Labs. These have been available for review since mid October. Thomason has also sent electronic copies of the Final Report and Individual Report to TCEQ/NTRD.

13. Review test results with TCEQ. (November 15, 2004)

Wade Thomason met with TCEQ/NTRD staff on behalf of Emissions Technology in September to discuss issues related to the grant project. However, a fruitful discussion of the test results between TCEQ and the grant recipient cannot take place prior to TCEQ reviewing the final project report, due to information presented in the report regarding the testing.

14. Submit draft final report to TCEQ. (November 30, 2004)

Submitted on January 7, 2005.

15. Submit final report to TCEQ. (December 20, 2004)

Submitted on January 18, 2005.

16. TCEQ accepts final report. (January 31, 2005 or sooner)

Test Vehicles

As stated previously, four test vehicles were chosen based on research conducted by Ed Martin to determine the types of gasoline fueled on-road vehicles that are major emitters and have significant numbers among vehicle populations in the Houston-Galveston and Dallas-Ft. Worth ozone nonattainment areas. Fleets, as well as the general vehicle population, were included. It was determined that the target vehicles would be light-duty pick up trucks from the years 1996-1998. However, one heavy-duty truck and one 2000 model vehicle were chosen due to availability issues. Both of these were good test vehicles because they fit the profile for mileage, engine size, fuel use, and other factors. While all efforts were made to keep the test vehicles within the target parameters, limited availability of vehicles due to the lack of a budget for vehicle procurement was a factor in the eventual selection of the test vehicles. The logistical issues involving getting the vehicles to the test facility were also not addressed in the inherited work plan.

Without the assistance of the Port of Houston Authority (POHA), finding and obtaining vehicles that fit the needed criteria for the project may have been difficult without incurring further costs. The POHA provided vehicles from their motor pool and delivered them to the test facility. Due to their support, the project team was able to resolve the issues of obtaining test vehicles that met the desired criteria and getting them to the test site in a safe and timely manner.

The test vehicles selected were as follows:

Table 1. Test Vehicles

Test Vehicle	Classification	Engine Size	Mileage
1998 Dodge Ram 1500	**Light Duty Truck**	**3.9L, V-6**	**99,814 miles**
1996 GMC Safari Van	**Light Duty Truck**	**4.3L, V-6**	**109,780 miles**
2000 Chevrolet 1500	**Light Duty Truck**	**5.0L, V-8**	**130,637 miles**
1997 Ford F350	**Heavy Duty Truck**	**5.8L, V-8**	**130,890 miles**

Test Procedures

In order to determine the effectiveness of the ECO-System technology, a comparison of emissions and fuel economy was conducted before and after installing the device. For each vehicle a series of three EPA-75 Federal Test Procedures (FTP) and three Highway Fuel Economy Tests (HWFET) were performed without the device installed. After the device was installed, each vehicle was given another series of three EPA-75 FTPs and three HWFETs. All testing was performed at Wallace Environmental Testing Laboratories, Inc. using the guidelines of 40CFR86.

The EPA Federal Test Procedure consists of three phases. The first phase is approximately 505 seconds, the second phase is approximately 870 seconds, and the third phase is 505 seconds. Between the second and third phase is a 540 second soak period. The HWFET consists of one phase that is 765 seconds.

Prior to testing, all fuel was drained. Commercially available, unleaded gasoline with an 87 octane rating was added to the vehicle. The fuel used in all the test vehicles was taken from the same batch to ensure consistency. One three-phase city driving cycle and one one-phase driving cycle were driven to accumulate 20 miles on the vehicle. The vehicle was then taken on the road for 4 heavy throttle accelerations. One three-phase city driving cycle and one one-phase driving cycle were driven to accumulate 20 miles on the vehicle. Three EPA-75 FTPs and three HWFET were then performed without the device.

The device was then installed on the vehicle's fuel line under the instruction of Emissions Technology of Texas. The fuel was drained again and fuel from the same batch of commercially available 87 octane fuel was added. One three-phase city driving cycle and one one-phase driving cycle were driven to accumulate 20 miles on the vehicle. The vehicle was then taken on the road for 4 heavy throttle accelerations. One three-phase city driving cycle and one one-phase driving cycle were driven to accumulate 20 miles on the vehicle. Three EPA-75 FTPs and three HWFET were then performed with the device installed.

For each EPA-75 FTP and HWFET, except those performed on the 1998 Dodge Ram 1500, the amount of fuel added to the vehicle prior to testing was measured into an external fuel tank. After each test the remaining fuel was drained and measured. The volumetric fuel economy was calculated by dividing the amount of fuel consumed during testing by the mileage accumulated during the test.

Test Results

As seen in Table 2. WETL, Inc. concluded that "the effect of adding the ECO-2 Vapor Pressure Enhancer was found in all instances to reduce most regulated emissions." More importantly, ozone precursors NOx and HC were reduced significantly in 75% of the test vehicles. Three of the vehicles had three-test average NOx reductions of -4.5%, -6.5%, and -17.2%, all significant average reductions. Three of the vehicles had three-test average HC reductions of -4.3%, -9.0%, and -13.1%, again, all significant average reductions.

Table 2. Test Results: EPA-75 Testing

Vehicle	**HC**	**CO**	**NOx**
1998 Dodge Ram 1500	**0.693%***	**-2.712%**	**-6.515%**
1996 GMC Safari	**-13.136%**	**-1.387%**	**-4.534%**
2000 Chevrolet 1500	**-4.307%**	**9.184%**	**-17.210%**
1997 Ford F350	**-9.029%**	**-2.415%**	**1.530%**

*Positive values indicate an increase in emissions levels.

However, if you look at the range of reductions, rather than the average or mean of three tests, as is called for in federal testing protocol, you get a truer sense of the potential for actual reductions that could be obtained. In Table 2. the 1997 Ford F350 has a three-test average of a 1.530% increase in NOx. In Table 3. the range of NOx reduction is -4.6%. This is derived by subtracting the lowest NOx result after installation of the device from the highest NOx result before installation of the device. Similarly, the three vehicles that fared well in reducing NOx on the three-test average, have a range of reduction of -9.8%, -19.8%, and -23.4%, indicating the strong potential to increase the measured level of NOx reduction if a longer term study were conducted under real world application.

Table 3. Test Results: Range of Reductions for Nitrogen Oxides (NOx)

Vehicle	Highest NOx Pre-Installation	Lowest NOx Post-Installation	Range of Reduction
1998 Ram 1500	.960 ppm*	.770 ppm	-19.8%
1996 GMC Safari	.669 ppm	.604 ppm	-9.8%
2000 Chevrolet 1500	.960 ppm	.736 ppm	-23.4%
1997 Ford F350	3.669 ppm	3.502 ppm	-4.6%

***Parts per million**

Table 4. reflects the range of reductions of hydrocarbons for each test vehicle follows a similar pattern as that for NOx. For example, the Dodge Ram 1500 has a three-test average of a .693% (less than 1%) increase in HC emissions. However, the range of reduction of HC for this vehicle is a -2.4% decrease. Looking at the three vehicles that fared well for reducing HC emissions on the three-test average, they show a range of reduction of -11.3%, -17.5%, and -22%, all significant increases over their three-test average. Again, this points up the potential for greater emissions reductions than are reflected in the three-test average.

Table 4. Test Results: Range of Reductions for Hydrocarbons (HC)

Vehicle	Highest HC Pre-Installation	Lowest HC Post-Installation	Range of Reduction
1998 Ram 1500	.632 ppm	.617 ppm	-2.4%
1996 GMC Safari	.346 ppm	.270 ppm	-22%
2000 Chevrolet 1500	.444 ppm	.394 ppm	-11.3%
1997 Ford F350	.836 ppm	.690 ppm	-17.5%

The issues of appropriate testing protocol and interpretation of results are crucial when attempting to demonstrate the effectiveness of this technology in reducing ozone precursors from mobile sources. Because the technology is already being used in the field with good results, it behooves us to go a little deeper than just evaluating the technology based on the three-test average method. A longer term assessment of the technology's effectiveness is warranted when attempting to quantify its benefits. One that would better reflect use under real world conditions, accumulating more road mileage and testing again at specified mileage intervals, would be more accurate in determining its actual emissions reduction benefits.

This is true for the fuel economy tests as well. Table 5. illustrates the results of the HWFET and volumetric fuel economy tests conducted by WETL, Inc. Again, the results are a three-test average taken before and after the device was installed. Before each series of tests, the vehicle was driven through two twenty mile drive cycles. While the device showed an improvement in fuel economy in 3 out of 4 vehicles using the HWFET method and in 2 out of 3 vehicles using the volumetric method, the overall results ranged from a -0.14% decrease in fuel economy to a 2.44% increase in fuel economy. Although overall the results were positive, it is felt that to get a truer picture of the technology's effectiveness in increasing fuel economy; a more long term test would be needed. This rationale is based on the fact that the technology enhances the combustion of the fuel without altering any of the components of the engine. Therefore, the impact of fuel economy benefits derived from increased efficiency will not be seen immediately, but rather will occur incrementally as the technology begins to reverse the build up of carbon in the engine. As this clean up process occurs over time, the fuel is now being combusted more completely, the engine is cleaner and running more efficiently and less fuel is needed to accomplish the same task.

Table 5. Test Results: Fuel Economy Tests

Vehicle	HWFET Fuel Economy	Volumetric Fuel Economy
1998 Ram 1500	1.37%	N/A#
1996 GMC Safari	-0.094%*	1.46%
2000 Chevrolet 1500	0.15%	-0.14%
1997 Ford F350	1.17%	2.44%

*A negative value indicates a decrease in fuel economy
#No volumetric fuel economy calculations were performed on the Dodge Ram 1500

The HWFET calculates fuel economy based on HC emissions. For the ECO-System technology, this method is problematic because you are working with a very short drive cycle that doesn't allow the technology to realize its full potential. All the test vehicles had accumulated mileage of approximately 100,000 to 130,000 miles. Operating the vehicle for 40 miles after installation of the device, prior to testing, is not adequate to fully evaluate the fuel economy benefit of the technology.

Volumetric fuel economy calculations are based upon the fuel consumed during the test. The volumetric method measures the leftover fuel in the gas tank, in this case, usually the 2-3 gallons remaining after driving the two 20 mile drive cycles and doing the FTP and HWFET testing. Because all the technology's benefits are not all realized immediately after installation, it would be prudent to have follow up testing done after the test vehicles have accumulated some mileage with the device installed. Repeating the FTP and HWFET testing at 500 miles, 1,000 miles, and 1,500 miles after installation would be a fairer assessment of the technology's capabilities. However, this was not possible for this project due to logistics, financial issues, and other limitations.

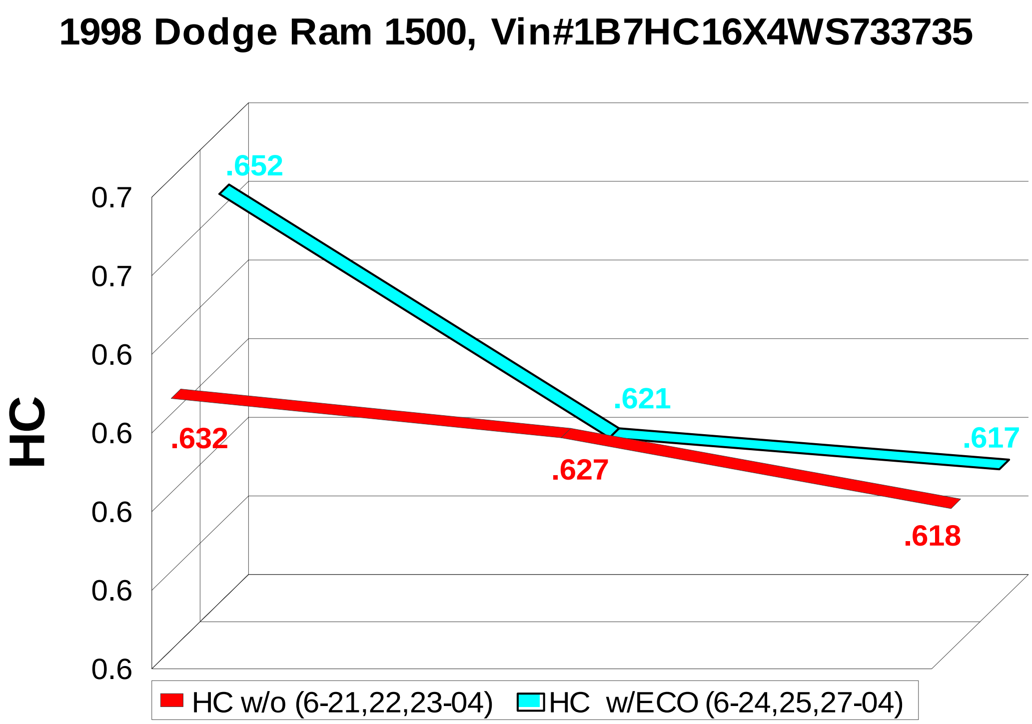
Understanding the Technology

To gain a better understanding of how the technology works, it is important to look again at the vehicle tests. All of the test vehicles had approximately 100,000 miles or more on them. Even with good maintenance there will be a considerable amount of carbon build up on the valves and piston heads, as well as varnish or paraffin in the fuel system. The ECO-System device not only increases the vapor pressure of the fuel, but also begins dissolving the varnish and carbon deposits. The emissions tests calculate the total emissions in the exhaust gas. HC is the fuel that is partially or completely unburned. Varnish is also HC based. As the technology dissolves these deposits, they are being added to the fuel. Therefore, it is not unrealistic to see the HC go up initially until these deposits are gone. This can create an unfair disadvantage in measuring fuel economy using the HWFET method because it is based on total HC emissions.

Two of the test vehicles experienced spikes in some emissions gases during the first test after the installation of the device. The 1998 Dodge Ram had its highest measured levels of HC (.652) and NOx (.994) during the first test after installation of the device. NOx is a gas created from heat and oxygen. Because the dissolved deposits are adding fuel to the system, they could easily increase combustion temperatures until they are removed. By the third after test, the vehicle measured its lowest levels for HC (.617) and NOx (.770). However, because of the three-test average method of evaluation, the initial spike skewed the averages for these emissions gases and the actual emissions reducing potential was not well reflected in the test results. The emissions for the three before and after tests for HC and NOx are shown in Graphs 1. and 2.

Graph 1. HC Emissions Tests

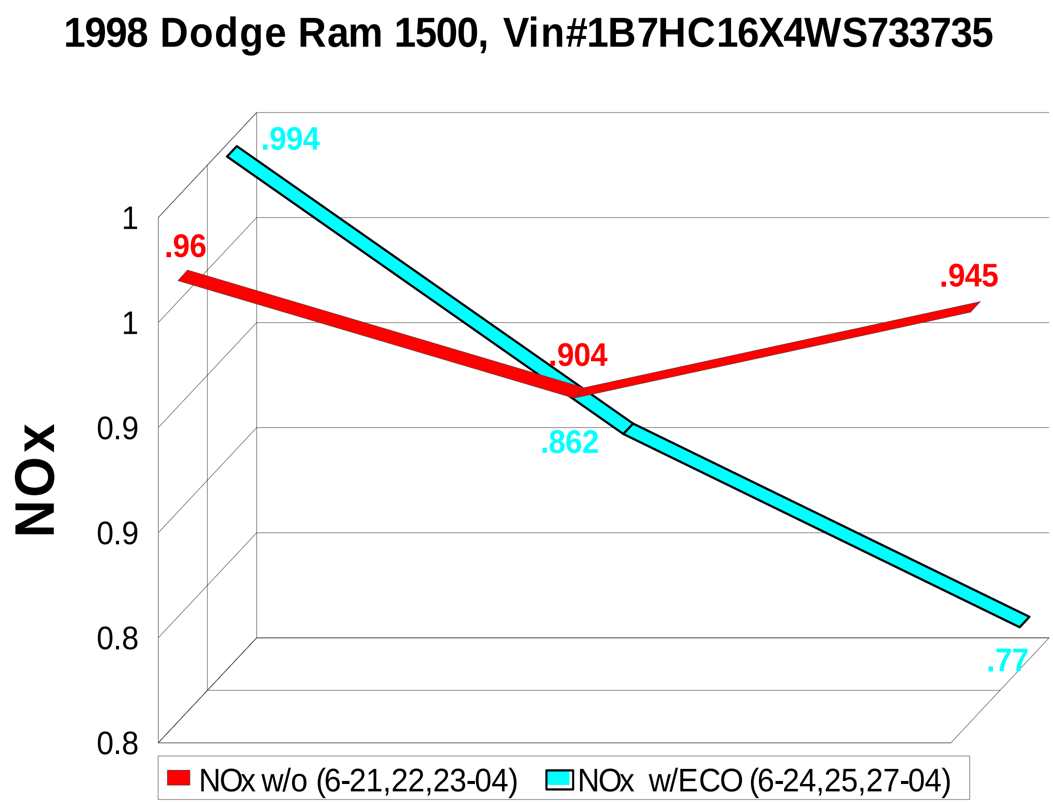
Wallace Environmental Testing Laboratories, Inc.
Houston, TX



Emissions Technology of Texas **(210) 842-0703**
Emissions Technology Inc., Tulsa, OK
(918) 663-2220

Graph 2. NOx Emissions Tests

Wallace Environmental Testing Laboratories, Inc.
Houston, TX



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Conclusions and Recommendations

The ECO-System technology fared well overall during emissions testing conducted during the summer of 2004 in Houston by Wallace Environmental Testing Laboratories, Inc. In particular, in most cases, ozone precursors NOx and HC were reduced significantly.

While test results for fuel economy were not as impressive, test procedures were felt to be inadequate to provide an accurate measurement for this technology due to a number of factors. These included too short of a drive cycle to allow the technology to fully function at its peak performance level, the potential for excess HC from the clean up process in the emissions gases that would impact the fuel economy negatively using the HWFET method, and the potential for error in measurement and calculations when dealing with such short drive cycles and small amounts of fuel as when using the volumetric method. A more long-term test plan is reasonable in this case to get a more accurate picture of the fuel economy benefit.

The future for the technology is good. As it is already in use in the field and has documented success with fuel economy and other benefits among several fleets, this laboratory emissions testing only strengthens the validity of the assertions of the manufacturer regarding its effectiveness at reducing emissions.

Truly, the technology holds great promise as an ozone reduction and fuel economy strategy that can be deployed cost-effectively on a large scale. In particular, high mileage fleets could be identified and targeted. Due to the financial constraints of this small business, however; it is unlikely that the manufacturer will pursue EPA Verification at this time without financial assistance and government support. It is an important goal of the manufacturer to keep the cost of the device as affordable as possible, making it accessible to all, including the less fortunate on the socioeconomic scale. The only feasible way for them to do this is to keep production costs low and outside expenses to a minimum. In today's economy that is the reality of economic survival for most small businesses.