EPA-AA-TEB-511-82-6A

EPA Evaluation of the Dresser Economizer Device Under Section 511 of the Motor Vehicle Information and Cost Savings Act

by

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Test and Evaluation Branch
Emission Control Techology Division
Office of Mobile Source Air Pollution Control
Environmental Protection Agency

EPA Evaluation of the "Dresser Economizer" Device under Section 511 of the Motor Vehicle Information and Cost Savings Act

The Motor Vehicle Information and Cost Savings Act requires that EPA evaluate fuel economy retrofit devices and publish a summary of each evaluation in the Federal Register.

EPA evaluations are originated upon the application of any manufacturer of a retrofit device, upon the request of the Federal Trade Commission, or upon the motion of the EPA Administrator. These studies are designed to determine whether the retrofit device increases fuel economy and to determine whether the representations made with respect to the device are accurate. The results of such studies are set forth in a series of reports, of which this is one.

The EPA evaluation of the Dresser Economizer device was conducted after receiving an application for evaluation by the manufacturer. The device is claimed to improve fuel economy and exhaust emission levels as well as vehicle performance. Because this device is basically a modified engine intake manifold gasket, in accordance with 40 CFR 610.21 of the regulations, it is classified by EPA as a fuel-air distribution device.

The following is the information on the device as supplied by the applicant and the resulting EPA analysis and conclusions.

1. Marketing Identification of the Device:

   "Dresser Economizer"

2. Inventors of the Device and Patents:

   a. Inventors

      "The inventor is Kenneth R. Armstrong assigned to Dresser Industries' Advanced Technology Center, 1702 McGaw, Irvine, California 92713."

   b. Patent

      "A patent application has been made (Number 87533), dated October 23, 1979" (A copy of the patent application was not provided.)

3. Manufacturer of the Device:

   Dresser Industries, Inc.
   1505 Elm Street
   Dallas, Texas 75201

4. Manufacturing Organization Principals:

   J.V. James, Chairman, Board of Directors
   J.R. Brown, Jr. President
   J.J. Murphy, Executive Vice President
   Duane D. Rost, Executive Vice President

5. Marketing Organization in U.S. Making Application:

Dresser Industries, Inc.
1505 Elm Street
Dallas, Texas 75201

6. Applying Organization Principals:

J.V. James, Chairman, Board of Directors
J.R. Brown, Jr. President
J.J. Murphy, Executive Vice President
Duane D. Rost, Executive Vice President

7. Description of Device:

a. Purpose of the Device (as supplied by Applicant):

"The economy device was initially developed as a means of reducing pulsation in the intake of four cylinder engines. While this effort was underway, economy gain was noted. Further exploration showed not only improved economy on most cars on which it was tested, but greatly improved driveability and cold start/performance in all cars tested. Since the three problems of economy, driveability, and cold start/performance are of such significance, Dresser Industries decided to market the technology."

b. Theory of Operation (as supplied by Applicant):

Based on information provided by the applicant (Attachment A), the device is a gasket containing shaped port passages which is installed between the intake manifold and the cylinder head (See Figure 2 in Attachment A). The size of each port passage in the gasket is approximately half that of the original unit. The applicant claims that the constriction increases the velocity and turbulence of the fuel-air mixture, thereby causing a more homogenous mixture. This activity enhances the combustion process by making it more rapid and effective which causes better fuel economy and improved driveability.

c. Construction and Operation (as supplied by Applicant):

"The device is fabricated as a composite intake manifold gasket stamped from metal with gasket material coated faces. Typical installation is shown in Figure 2 and a photograph of a device in Figure 3. (See Attachment A for Figures 2 and 3)

"The radiused unit is considered standard."

8. Applicability of Device (as supplied by Applicant):

"Based on our test results to date, the device will improve driveability and cold performance on all cars and trucks. It will improve economy on most carbureted cars and trucks. The exceptions found are those having electronic engine controls (spark and/or feed back carburetion) and the Ford Windsor engine family (351, 302, etc.) where only a small gain (1-2 percent) is shown.

"In some instances where engines have odd intake shapes (e.g., 292 six-cylinder Chevrolet) a special shape must be derived."

9. Costs (as supplied by Applicant):

In a letter to EPA (Attachment B of this evaluation) the applicant stated, "the retail cost of the Dresser Economy Device has not yet been established but probably would be in the range of $15 to $25."

10. Device Installation, Tools and Expertise Required (as supplied by Applicant):

"The device installation is identical to that of an intake manifold gasket and installation instructions are the same as specified by vehicle manufacturers. Tools, skills required, etc., are the same."

11. Device Operation (as supplied by Applicant):

"Install as per intake manifold gasket replacement with marked side toward carburetor (protrusion toward cylinder). Test drive. If knock is evident, reduce basic spark advance to eliminate."

12. Device Maintenance (claimed):

"No maintenance is required."

13. Effects on Vehicle Emissions (nonregulated) (claimed):

"No effect."

14. Effects on Vehicle Safety (claimed):

"The device has no adverse effect on vehicle safety. Power loss, which can occur with the device is only at the combination of high RPM and wide open throttle, a condition which can rarely if ever be attained.

"The improved driveability of the device in itself provides increased safety by reducing/eliminating sag and stall."

15. Test Results - Regulated Emissions and Fuel Economy (submitted by Applicant):

The applicant provided exhaust emission, fuel economy, and performance test results (Attachments C and C-1 through C-4) generated at the Dresser Advanced Technology Center and at Systems Control, Inc.

16. Testing by EPA:

Because the test data submitted by the Applicant suggested there are potential fuel economy benefits associated with the device, EPA conducted confirmatory testing. EPA developed a Test Plan/Test Agreement which was sent to the Applicant for review and concurrence (Attachment D). Subsequently, a revised Test Plan/Test Agreement was sent to the applicant (Attachment E) for concurrence. The Applicant concurred (Attachment F) that the revised test plan would accurately reflect the effectiveness of the device.

a detailed description of the testing conducted by the EPA in support of this evaluation is reflected in EPA report, EPA-AA-TEB-82-3, (Attachment G). A brief description of this testing effort is provided below:

Four recent model year vehicles (Plymouth Volare with a 225 CID engine, Chevrolet Nova with a 350 CID engine, a Chevrolet Laguna with a 350 CID engine, and an Oldsmobile Cutlass with a 231 CID) were tested for emissions and fuel economy. Tests were conducted according to the Federal Test Procedure (FTP) and Highway Fuel Economy Test (HFET). The test program consisted of duplicate FTP and HFET tests with and without the Dresser Economizer installed. In addition to the FTP and HFET tests, performance was also evaluated by wide-open-throttle accelerations from 5 mph to 60 mph while on the chassis dynamometer. Starting characteristics and driveability were also observed at all times under both cold and warm engine conditions.

EPA's findings from this testing are listed below:

1. Hydrocarbon emissions varied from no change to a gain of 22% on the FTP and from a gain of 39% to a reduction of 10% on the HFET.

2. Carbon monoxide emissions varied from a gain of 22% to a reduction of 13% on the FTP and from a gain of 50% to a reduction of 18% on the HFET.

3. Oxides of nitrogen changes ranged from a gain of 57% to a reduction of 4% on the FTP and from a gain of 61% to a reduction of 17% on the HFET.

4. Fuel economy varied from a penalty of 3% to a gain of 4% on the FTP and from a penalty of 3% to a gain of 2% on the HFET.

5. The Dresser Economizer caused the acceleration times from 5 mph to 60 mph to increase from 1% to 10%, however, this would not be noticed by most drivers.

6. Although the evaluation was subjective, driveability of the vehicles under both cold and warm conditions was not noticeably affected.

In general, the device caused varying test results among the test vehicles and no definite trends were noticed. This was also true even for vehicles with similar engine configurations. None of the improvements in fuel economy or emissions were statistically significant.

17. Analysis

a. Description of the Device:

The device is judged to be adequately described in Section 7.

b. Applicability of the Device:

The applicant states, "the device will improve driveability and cold performance on all cars and trucks. It will improve economy on most carbureted cars and trucks. The exceptions found are those having electronic engine controls (spark and/or feed back carburetion) and the Ford Windsor engine family (351, 302, etc.) where only a small gain (1-2 percent) is shown". From these statements, it appeared the Dresser Economizer is applicable to more than conventional gasoline-fueled piston type engines. That is, it is intended to be used on turbine and rotary type engines and also on propane and gasohol fueled engines. In a letter to the applicant (Attachment H) EPA questioned the applicability of the device. The applicant responded (Attachment B) that the device is presently intended only for carbureted gasoline-fueled engines. Although not specifically stated, it is assumed the applicant is referring to piston type engines.

Based on EPA's understanding of the applicability of the device, a test program was developed for EPA testing of the Dresser Economizer. Because the applicant did not specifically exclude 1980 and 1981 model year vehicles with electronic engine controls (spark and/or feedback carburetion), EPA planned to test vehicles representing those model years. In subsequent oral discussions with the applicant, EPA learned that these vehicles were not appropriate test vehicles. Therefore, EPA revised the test program to test only 1979 and earlier model year vehicles.

c. Costs:

According to a letter from the applicant to EPA (Attachment B) the cost of the Dresser Economizer is expected to be in the range of $15 to $25. The miles one would have to drive to recover the cost of the device was estimated by using the fuel economy levels and gains realized during the EPA testing of the Chevrolet Laguna. The Laguna test results were used because the largest gains were achieved with that vehicle. Combining the

FTP and HFET test results on a 55/45 ratio respectively, a composite fuel economy value was calculated for each the Baseline and Device test configurations. These values resulted in a 3 percent fuel economy gain as a result of using the device. At a fuel economy level of 14 MPG, a 3 percent gain would mean one would have to drive approximately 5300 miles to recover the cost of the device. This is assuming a cost of $15 per device and $1.40 per gallon of gasoline.

The estimated price of the device does not include the cost of installation. Considering that many purchasers of the device will have the device installed at a service facility, an additional expense would be incurred. Assuming 2 to 3 hours for installing the device at a labor rate of $20 per hour, the cost could be an additional $40 to $60. This means the miles required to be driven would need to be increased by a factor of 3 to 5. For those vehicles with high odometer mileage at the time of device installation, the amount of operation necessary to recover the cost of the device may exceed the remaining life of the vehicle.

d. <u>Device Installation - Tools and Expertise Required:</u>

The applicant states that the "installation instructions are the same as specified by vehicle manufacturers". EPA takes exception to this statement in that the installation instructions recommend retarding of the initial timing should the device cause a detonation problem. EPA believes this recommendation is inappropriate for the installation of an OEM gasket. EPA does agree with the applicant in that the device installation is identical to that of an intake manifold gasket and that the tools and skills required are the same. In general, the installation instructions were judged to be adequate.

e. <u>Device Operation:</u>

The operating instructions referred to in Section II consist of additional installation instructions. Additionally, it is stated that the vehicle should be driven after installation of the device. If detonation is a problem, spark advance should be retarded. Aside from this, EPA does not expect there to be any further actions required by the driver.

f. <u>Device Maintenance:</u>

The applicant states that "no maintenance is required". Although the applicant did not provide any data showing the short and long term effects of the device, EPA does not expect there to be a durability problem or the need for maintenance.

g. Effects on Vehicle Emissions (nonregulated):

As claimed, the device is judged to be unlikely to affect nonregulated emissions.

h. Effects on Vehicle Safety:

EPA agrees with the applicant in that the device should not cause a safety problem and that the slight loss in engine power is of little consequence.

i. Test Results Supplied by Applicant:

The applicant did submit test data in accordance with the Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFET). The requirement for test data following these procedures is stated in the test policy documents that EPA sends to potential applicants.* The test data submitted by the applicant are listed below and evaluated.

(1) Attachments C-1 and C-2 contain test results obtained at Dresser Industrie's test facility. The summary of test results in Attachment C-1 were for 11 test vehicles while the detailed test results in Attachment C-2 also included those for test vehicle Number 12. All 12 vehicles were from the 1971 to 1979 era.

The test results showed that exhaust emissions varied considerably in both a positive and negative manner. Five vehicles exceeded their emission standards when tested with the device. In most instances, this was attributed to oxides of nitrogen (NOx). The test results also showed an average gain in fuel economy of approximately 8 percent and 7 percent for the FTP and HFET, respectively.

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* From EPA 511 Application test policy documents:

Test Results (Regulated Emissions and Fuel Economy):
Provide all test information which is available on the effects of the device on vehicle emissions and fuel economy.

The Federal Test Procedure (40 CFR Part 86) is the primary test which is recognized by the U.S. Environmental Protection Agency for the evaluation of vehicle emissions. The Federal Test Procedure and the Highway Fuel Economy Test (40 CFR Part 600) are the only tests which are normally recognized by the U.S. EPA for evaluating vehicle fuel economy. Data which have been collected in accordance with other standardized fuel economy measuring procedures (e.g. Society of Automotive Engineers) are acceptable as supplemental data to the Federal Test Procedure and Highway Fuel Economy Test and will be used in the preliminary evaluation of the device.

(2) Attachments C-3 and C-4 contained exhaust emission and fuel economy test results obtained at Systems Control Incorporated (SCI) and performance data obtained at the Orange County International Raceway by both Dresser Industries and SCI. The SCI data was from three vehicles (Nos. 8. 9. and 11) which were also tested by Dresser Industries. These results showed an average fuel economy gain of 10 percent for both the FTP and HFET. This substantiates Dresser test results which also showed a 10 percent gain over the FTP and HFET on the same three vehicles. The exhaust emissions also showed considerable variations.

The performance data consisted of wide-open-throttle accelerations which showed an improvement in some instances and adverse effects in others. In general, the performance did not appear to be significantly affected and would not likely be noticed by the average driver.

(3) Because the applicant stated that Dresser Industries had recently performed additional tests on newer vehicles, EPA requested (Attachment H) that these test results be provided to EPA. The applicant did provide (Attachment B) the test results which had been generated using six 1978 through 1981 model year vehicles. These results showed that emissions varied considerably with one vehicle excceeding the emission standards for NOx. With respect to average fuel economy, there was a penalty associated with the use of the device. However, this penalty was considered to be negligible. The applicant attributes the insignificant changes to the electronic control systems used on the engines.

Overall, the data submitted by the applicant for 1979 and earlier model years indicated there are potential benefits associated with the Dresser Economizer. For this reason, EPA elected to test the device.

18. <u>Conclusions</u>

EPA fully considered all of the information submitted by the device manufacturer in his application. The evaluation of the Dresser Economizer device was based on that information and the results of the EPA test program.

The test data submitted by the applicant showed fuel economy and emission benefits when using the Dresser Economizer while the results from the EPA test program showed that for three of the four vehicles tested there were no benefits associated with the device. Even for the one vehicle which did show a benefit, the gain was determined not to be statistically significant. EPA does not know why the test results supplied by the applicant differed from those achieved from the EPA test program. The difference may be attributed to greater test-to-test variability at the applicant's laboratory or to the vehicles themselves. In any case, EPA must base its conclusion on the test results obtained from four typical vehicles tested under closely controlled conditions at its own facility. Based on those results, EPA has determined that it can not support the claims made with respect to the emissions, fuel economy, performance, and driveability benefits associated with the Dresser Economizer.

FOR FURTHER INFORMATION CONTACT: Merrill W. Korth, Emission Control Technology Division, Office of Mobile Sources, Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan 48105, (313) 668-4299.

The following information is extracted from the Application for Evaluation of the Dresser Economizer Fuel Economy Retrofit Device.

b) <u>Theory of Operation:</u> The economy device modifies the combustion process of the internal combustion engine to provide a more rapid and effective combustion.

As a result of the enhanced combustion, the following occurs:

- Increased economy. Economy increase of 0-20 percent obtained with a wide variety of cars tested.
- Increased driveability. In all cars tested, driveability is improved substantially.
- Cold performance. Cold start and cold performance are vastly improved.

- EGR tolerance. The car can tolerate much greater amounts (more than double) of EGR while still having excellent driveability. This is extremely important in OEM applications, particularly for achieving low NOx emission levels.

- Knock sensitivity. In some cases (not consistent) knocking is increased. This appears to be controlled with spark modifications.

- NOx emission. In some cases, NOx emissions increase slightly. This also can be controlled by spark and/or EGR and/or A/F ratio.

In some cases, the overall combination of enhanced combustion rate and spark is too great and does not result in economy gain but will provide gain if the amount of spark is reduced.

The device is placed in the intake runner and restricts the charge flow path increasing its velocity. In most cases, the restriction must be greater than 45 percent to produce an effect and preferably in the range of 60 percent for optimal results. Further increase produces further economy gain but at the sacrifice of top-end power (not necessarily bad).

In intake runners, a complex stratification can occur. Generally, this takes two forms.

- Phase separation when larger fuel droplets fall out of the air stream onto the manifold floor and flow along the floor toward the intake valve.

- Velocity distribution where the flow profile exhibits a preferential flow area, where a higher velocity and probably a higher density exists. On the V-8 engines the top of the runner apparently carries most of the flow, because the flow is generally turning down into into the cylinder. On the in-line engines, the majority of flow is most probably on the outside radius of the runner. As the runner size decreases, this type of stratification becomes less noticeable.

The economy device functions by effectively removing both of the above kinds of stratificatin, close enough to the intake valve and cylinder to prevent restratification. This is done by restricting the flow area and rapidly expanding the flow to minimize the frictional flow loss. In so doing, the fuel is reentrained and the flow profile made more uniform. Specifically, how this is accomplished has a large affect on the improvements gained, particularly in the larger cross-section runners.

In order to remix the fuel back into the airstream, the fuel must be either lifted from the floor or the air diverted to the floor in the restricted zone. Either of these methods results in large economy gain. If the air's preferential path is on the upper portion of the runner, however, diverting it to the floor by blocking the upper portion of the runner, results in a much larger power loss than blocking other portions of the flow, eg, the bottom.

Specific Findings

Tests have been run on a wide variety of cars. These results are presented in Section 12.

A series of tests were conducted to evaluate the effects of various blockage shapes and sizes. This work was done on a 1978 Chevrolet Caprice equipped with a 350 CID engine. Results indicate the following:

Size: Economy begins to increase at about 45 percent reduction and continues to increase with decreasing size. This parameter was explored until the size decrease had a very obvious effect on the power loss, noticeable in driving. Our results indicate that a power loss of 15 - 20 percent or less is not noticeable in driving the car.

Similar results were obtained on a 400 CID Mercury:

Shape-Radius: If the holes in the restriction are provided with a radiused edge so that the flow path leading to the valve is smooth, somewhat greater economy increase is obtained and power loss is significantly reduced.

Shape-Round: A round hole appears to give similar results to a rectangular hole. Varying the number of holes however while keeping the same area restriction shows similar results for two holes but decreasing economy gain and power loss with more than two holes.

__Location:__ Significant variations are found depending on which portion of the runner cross section is left open or conversely which portion is blocked. When the bottom is open, significant economy gain is obtained with minimal restriction; however, power loss and NOx gain are considerable. Comparison of the results with centrally located holes, at equivalent power loss shows results to be almost identical. It appears flow on the manifold floor is good for economy but diverting the flow to the bottom is bad and the restriction __acts as if__ it is much greater. Perhaps this is due to a severe vena contracta formed by the flow.

Opening only a portion of the bottom and some of the center, reduces the severe power loss and economy gain but both are still greater than a center hole. Interestingly, if compared at equivalent power loss, NOx would be significantly lower.

Opening the top portion of the runner (blocking the bottom) gives equivalent power loss but economy is much lower in comparison with a central hole (again it appears that the bottom opening is important for economy).

Opening the sides of the runners produced further interesting results. Two types of openings were looked at, one opening the inside of the runners where the inside is defined as the two common surfaces of the siamesed runner and the other just the opposite, designated the outside.

The results show the outside to have slightly increased economy and power loss compared to an equivalent hole where the inside has the same economy and power loss. However, NOx is significantly lower than either with the inside pairing. The results show the outside to have slightly increased economy and power loss compared to an equivalent hole where the inside has the same economy and power loss. However, NOx is significantly lower than either with the inside pairing.

<u>EGR Tolerance:</u> One of the benefits found in this evaluation was that use of the economy device greatly enhances the tolerance of the engine for EGR and/or charge dilution. These results are shown in Figure 1. The base car was borderline in its driveability with the base amount of EGR.

Results show that an equivalent economy gain is possible in the Economizer equipped car with or without EGR. Also, EGR, double the EGR, and double the EGR with further air dilution (vacuum leak) gave very little economy loss while still maintaining excellent driveability. Addition of EGR to the base car gave considerable economy loss. This EGR tolerance can of course be of extreme importance to meeting low NOx levels or to possible lean operation at low NOx levels.

c) <u>Detailed Description of Construction and Operation:</u> The device is fabricated as a composite intake manifold gasket stamped from metal with gasket material coated faces. Typical installation is shown in Figure 2 and a photograph of a device in Figure 3.

The radiused unit is considered standard.

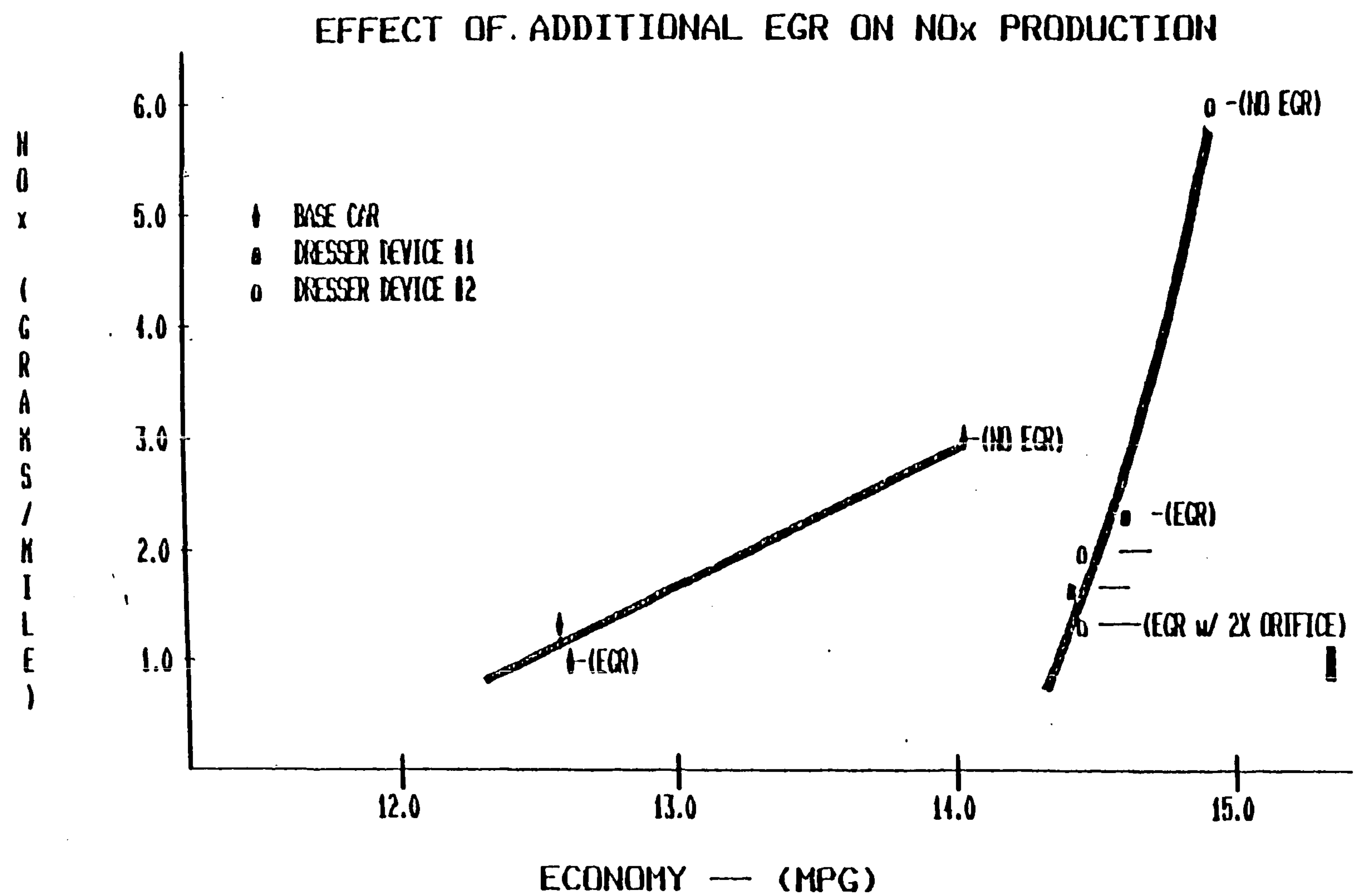
EFFECT OF ADDITIONAL EGR ON NOx PRODUCTION
NOx (GRAMS/MILE)
6.0
5.0
4.0
3.0
2.0
1.0
BASE CAR
DRESSER DEVICE #1
DRESSER DEVICE #2
-(NO EGR)
-(NO EGR)
-(EGR)
-(EGR)
-(EGR w/ 2X ORIFICE)
12.0
13.0
14.0
15.0
ECONOMY — (MPG)

FIGURE 1

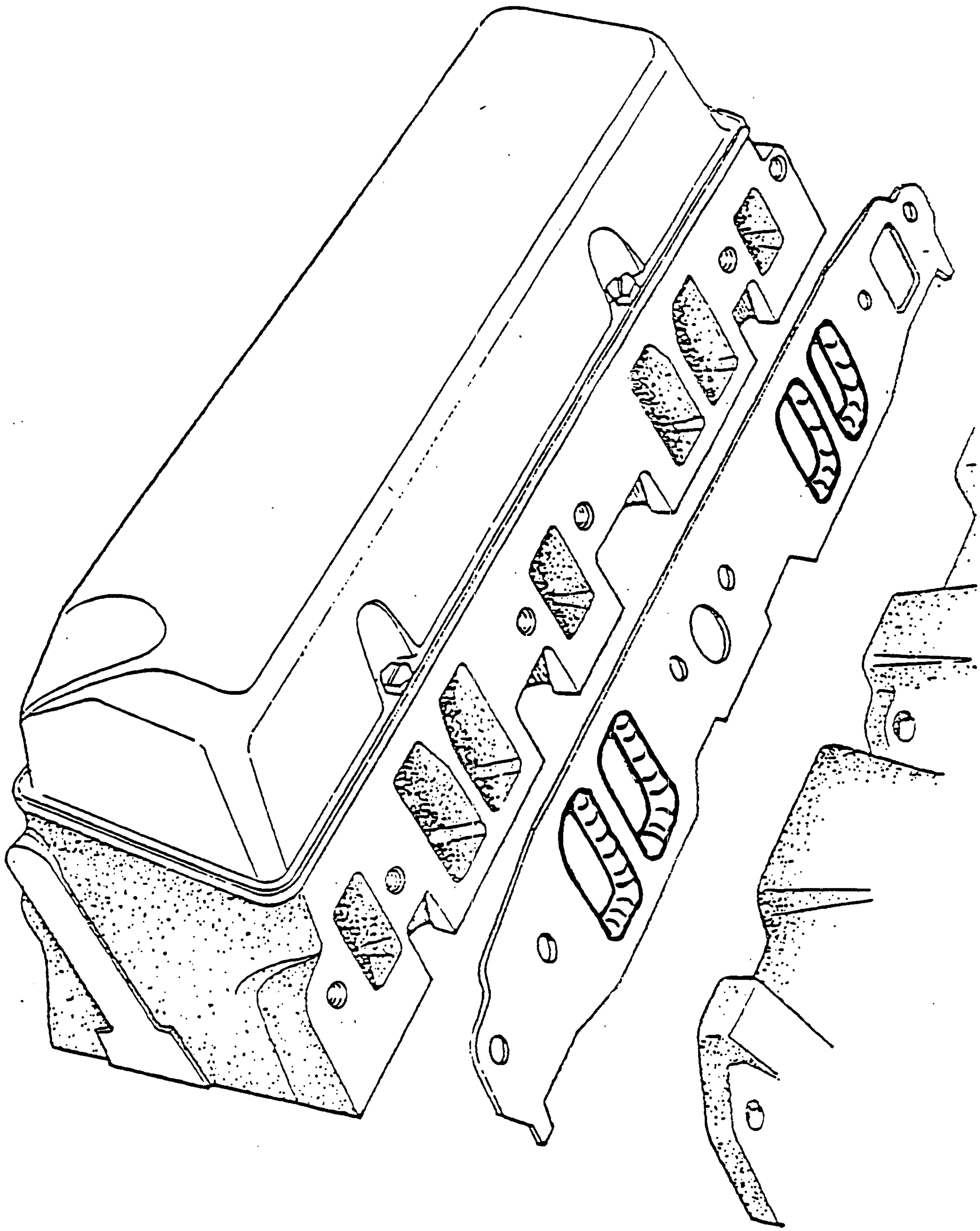

FIGURE 2

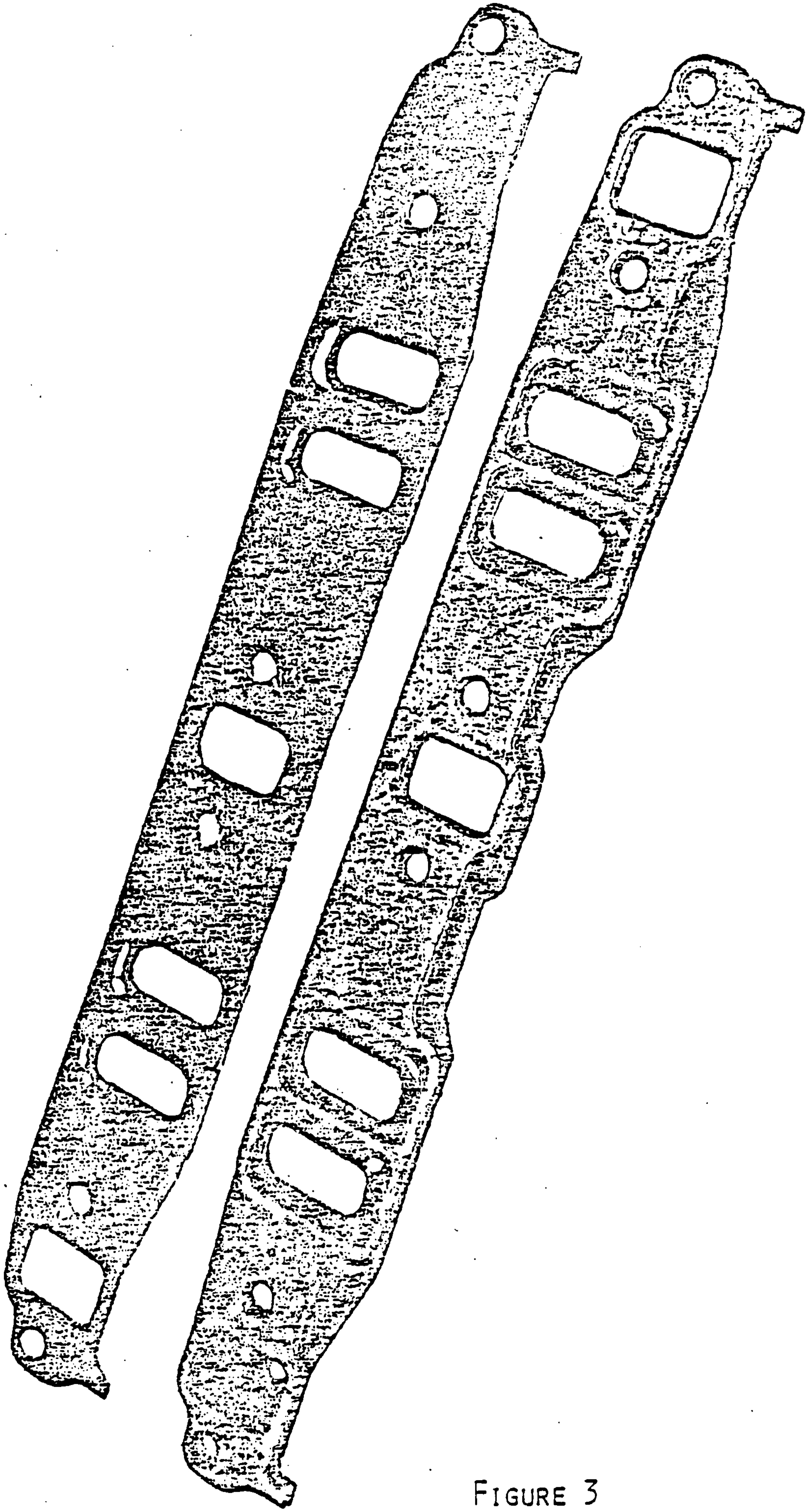

FIGURE 3

Attachment B

DRESSER INDUSTRIES

ADVANCED TECHNOLOGY CENTER □ DRESSER INDUSTRIES, INC □ 1702 McGAW □ P O BOX 19566 □ IRVINE, CALIF 92713

August 3, 1981

Mr. Merrill W. Korth
Device Evaluation Coordinator
Test and Evaluation Branch
U.S. Environmental Protection Agency
Ann Arbor, Michigan 48105

Dear Mr. Korth:

In reference to your letter of July 14, 1981, I wish to provide you with the following additional information as per your request. Comments are in the same order as in your letter.

Item 1. In reference to Section 8A of the application, aside from the performance test, our evaluation of driveability and cold start performance is subjective and was determined mainly by our own staff driving cars before and after addition of the device. In no case did any car have decreased driveability and, as reported, in most cases driveability was considerably enhanced. This included elimination of sag and stumble on acceleration.

Cold start was also evaluated subjectively by our employees who would drive these cars over a period of time and compare the cold start performance before and after. In general, these cold starts were not under severe winter conditions since such a climate does not exist here but improvement was readily apparent particularly on our coldest days.

Further but more specific indication of cold start improvement is the improved capability to cold start lean as observed in our 0.4 GPM NOx demonstration car. The addition of the device allowed us to cold start on the CVS cycle at 16.5 to 1 air fuel ratio as contrasted to the case without the device when the start would have to be made at 15-15.5 to 1 air fuel ratio.

Item 2. In reference to Section 8B, the restriction refers to reduction in comparison to the standard intake manifold cross sectional area as exists on the OEM production car. We have developed a design criterion which relates the size of the restriction directly to engine size and provides a means to size the device independent of the intake runner size or the number of cylinders. This procedure is confidential and is the basis of our patents applied for.

Item 3. In reference to Section 9, currently we are only concerned with driveability, cold performance, and economy on carbureted cars and trucks operating on gasoline since this is the only type of engines on which we have conducted tests. Therefore, Section 9 should be construed in this light. However, we did conduct some tests on propane which showed about half the gain that we achieved with the gasoline fueled engine and we would anticipate that the device would work quite well with gasohol or alcohol fuels. However, at this time, we are limiting its application to carbureted gasoline fueled engines. The basis for the claims concerning driveability and cold performance is the results of our tests in which both of these factors have only been influenced positively and we are extrapolating to other cars. The same is true for the economy.

In reference to Item 3B, it is our intention to market the device initially in the standard configuration which is a radiused hole and, as mentioned earlier, the size is determined in relation to the engine size, the number of cylinders, etc., as per our design procedure which is the basis of our patent application. At a later time, after further testing, designs specific for an engine family might be found which would be considered a product improvement.

We do not know of other engine vehicle configurations than the Ford 351-302 Windsor family on which the device does not function other than the newer cars equipped with engine control systems as mentioned in the application.

In reference to a marketing plan for the device, it would be our intention to market initially to the major engine families and only to those on which the device provided demonstrable economy gains. We would anticipate a continuing effort identifying engine families and performance as the product was developed to other engine types and families.

Driveability improvement itself might be significant enough to warrant cost of retrofitting an engine family such as the Ford 351-302 which shows marginal economy gain. If such should be the case, the device would not be marketed as improving economy.

Item 4. Reference to Section 10 of the application, installation instructions would be included with the device; however, its installation is simply as a replacement for the intake manifold gasket which is well known to mechanics and do-it-yourselfers. Currently, the only units we have available are prototype units. We would be happy to send one to you for examination. The retail cost of the Dresser Economy Device has not as yet been established but probably would be in the range of $15 to $25.

<u>Item 5.</u> In reference to Section 15, the detailed test results submitted with the application were those on which we had comparative data and represent the major portion of our testing. There exists a considerable body of data which were obtained during development of the device in reference to size, shape, etc., which we feel are not significant to this evaluation. Attached is the data summary of our tests on the newer cars which you have requested and, in addition, test summaries on a Ford 302 engine which was done in confirmation of the fact that this engine family does not respond.

I hope that the above answers the questions that you had regarding this device and we are prepared to assist in any way in your evaluation.

Sincerely,

L. P. Berriman
Director of Engineering

LPB:rl

cc: M. K. Dishman
N. Colbert

Attachments

C.V.S. Testing Conducted at Dresser Advanced Technology Center, Irvine, CA

Car No. - Oldsmobile Cutlass V-6 - Model Year - 1980 - 231CID (3.8L) License #045ZLE California

73 F.T.P. - City Cycle (Hot Start) (LA-4)

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(c)	3	0.02	2.09	0.64	514.9	17.13
WITH DEVICE	(d)	1	0.03	0.57	2.40	524.7	16.89
VARIANCE			+0.01	-1.52	+1.76	+9.8	-0.24
IMPROVEMENT							-1.40%

Highway Fuel Economy

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(e)	3	0.02	1.44	0.29	353.1	24.98
WITH DEVICE	(f)	1	0.02	0.05	1.66	358.9	24.72
VARIANCE			0.00	-1.39	+1.37	+5.8	-0.26
IMPROVEMENT							-1.04%

C.V.S. Testing Conducted at Dresser Advanced Technology Center, Irvine, CA

Car No. - Toyota Corolla - Model Year - 1981 - 1.8L - License #1ANV633 California

73 F.T.P. - City Cycle (Hot Stout) (LA-4)

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(c)	4	0.04	1.02	0.32	337.2	23.43
WITH DEVICE	(d)	4	0.02	0.70	0.39	370.6	23.40
VARIANCE			-0.02	-0.32	+.07	-6.6	-0.03
IMPROVEMENT							-0.13%

Highway Fuel Economy

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(e)	4	0.07	2.92	0.07	305.2	28.65
WITH DEVICE	(f)	4	0.06	1.99	0.11	304.2	28.88
VARIANCE			-0.01	-0.93	+0.04	-1.0	-0.23
IMPROVEMENT							0.80%

C.V.S. Testing Conducted at Dresser Advanced Technology Center, Irvine, CA

Car No. - Chevrolet Chevette - Model Year - 1981 - 1.6L License #1BCJ034 California

73 FTP City Cycle - (Hot Start) (LA-4)

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(c)	5	0.05	1.16	0.70	349.8	25.24
WITH DEVICE	(d)	3	0.05	1.13	0.99	348.2	25.35
VARIANCE			0.00	-0.03	+0.29	-1.6	+0.11
IMPROVEMENT							0.44%

Highway Fuel Economy

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(e)	5	0.02	0.47	1.05	252.4	35.07
WITH DEVICE	(f)	3	0.02	0.52	0.98	254.3	34.78
VARIANCE			0.00	+0.05	-0.07	+1.9	-0.29
IMPROVEMENT							-0.83%

C.V.S. Testing Conducted at Dresser Advanced Technology Center, Irvine, CA

Car No. - Chevrolet Citation V-6 - Model Year - 1980 - 173 CID (2.8L) License #996YTY California

73 F.T.P. City Cycle (Hot Start) (LA-4)

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(c)	3	0.03	1.56	0.57	515.1	17.15
WITH DEVICE	(d)	3	0.02	1.25	0.75	506.0	17.47
VARIANCE			-0.01	-0.31	+0.18	-9.1	+0.32
IMPROVEMENT							1.87%

Highway Fuel Economy

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(c)	3	0.03	2.09	0.30	363.5	24.19
WITH DEVICE	(f)	3	0.02	1.57	0.44	355.8	24.77
VARIANCE			-0.01	-0.52	+0.14	-7.7	+0.58
IMPROVEMENT							2.40%

C.V.S. Testing Conducted at Dresser Advanced Technology Center, Irvine, CA

Car No. - Pontiac Sunbird L-4 - Model Year - 1980 - 151 CID - License #045ZLE California

73 F.T.P. - City Cycle (Hot Start) (LA-4)

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(c)	3	0.03	1.73	0.65	456.9	19.31
WITH DEVICE	(d)	2	0.03	1.65	0.82	462.8	19.07
VARIANCE			0.00	-0.08	+0.17	-5.9	-0.24
IMPROVEMENT							-1.24%

Highway Fuel Economy

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(e)	3	0.01	0.63	0.91	330.7	26.76
WITH DEVICE*	(f)	2	0.02	0.98	1.28	343.4	25.74
VARIANCE			+0.01	+0.35	+0.37	+12.7	-1.02
IMPROVEMENT							-3.81%

* Tests run at 5^{o} retard to eliminate spark knock.

C.V.S. Testing Conducted at Dresser Advanced Technology Center, Irvine, CA

Car No. - Mercury Zepher - Model Year - 1978 - 302 CID License #614SGR California

73 F.T.P. - C.V.S. City Cycle (Hot Start) (LA-4)

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(c)	6	0.47	0.14	1.02	520.9	17.04
WITH DEVICE	(d)	2	0.53	0.15	1.43	522.2	16.94
VARIANCE			+0.06	+0.01	+0.41	+1.3	-0.10
IMPROVEMENT							-0.59%

Highway Fuel Economy

	Test Series	Number Tests Performed (Average)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	CO_2 (g/mi)	MPG
BASELINE	(e)	6	0.30	0.16	1.08	421.8	20.99
WITH DEVICE	(f)	2	0.36	0.16	1.38	419.6	21.09
VARIANCE			+0.06	0.00	+0.30	-2.2	+0.10
IMPROVEMENT							0.48%