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Emissions and Fuel Economy of FUEL-MAX, a Retrofit Device

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Abstract

This report describes the results of testing the "FUEL-MAX" device as part of an evaluation under Section 511 of the Motor Vehicle Information and Cost Savings Act. The FUEL-MAX is an air-bleed device which replaces a vehicle's Exhaust Gas Recirculation (EGR) valve. The amount of air bled into the intake manifold is determined by the vacuum signal which once controlled the action of the EGR valve. This device is claimed to conserve fuel. The primary purpose of this project was to evaluate the effect of the FUEL-MAX on exhaust emissions and fuel economy.

Testing of three typical 1979 model year passenger cars was conducted during March, 1981. The basic test sequence included the Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFET). These tests were performed both before and after installation of the FUEL-MAX. As a result of the testing, average hydrocarbon and carbon monoxide emissions decreased somewhat while oxides of nitrogen displayed substantial increases. Fuel economy was found to increase approximately three percent on the FTP but exhibited no change over the HFET. The occurrence of engine knock was obvious on two of three vehicles. EPA's Office of Enforcement has determined that the FUEL-MAX can violate the anti-tampering provisions of the Clean Air Act.

Background

Section 511 of the Motor Vehicle Cost Savings and Information Act empowers the Environmental Protection Agency (EPA) to evaluate devices or fuel additives which may improve the fuel economy of conventional motor vehicles. The EPA has developed and instituted a procedure whereby an individual or organization may apply for an evaluation of the device or fuel additive. This procedure requires the applicant to submit a technical description of the system in conjunction with results from actual testing. Once a complete application is received, the EPA will conduct an engineering evaluation and publish the results in the Federal Register. In those cases where the device or additive shows promise, the EPA will conduct tests as a part of its evaluation. Such testing is performed at EPA's Motor Vehicle Emission Laboratory in Ann Arbor.

In February, 1980, EPA received an application from Fuel Injection Development Corporation for an evaluation of the FUEL-MAX. This device is an air-bleed mechanism which replaces the Exhaust Gas Recirculation (EGR) valve. The amount of air bled into the intake manifold is determined by the vacuum signal which once controlled the action of the EGR valve.

Based on an evaluation of the test results submitted to support the claims for the FUEL-MAX, EPA chose to conduct confirmatory testing. The basic purpose of the testing was to determine the effect of the device on fuel economy and exhaust emissions. Secondary purposes included an evaluation of the installation instructions and driveability factors.

Test Vehicles

Three typical 1979 production vehicles were used: a Ford Pinto with a 4-cylinder engine, an Oldsmobile Cutlass with a 6 cylinder engine, and a Mercury Zephyr with an 8 cylinder engine. All vehicles were equipped with automatic transmissions. A more detailed description of each vehicle is provided in Appendix A.

Test Fuel

Commercial, unleaded regular fuel was used in the testing of the FUEL-MAX. A single batch of the fuel was purchased and stored at the EPA. The motor octane number was 83 while the research octane number was 91. The decision to use a commercial fuel was based upon the knock sensitivity of some engines to EGR deactivation. The Indolene fuel used in EPA testing has a higher octane rating than typical commercial unleaded gasoline. Thus, use of commercial fuel was appropriate for this evaluation where the possibility of increased knock was probable.

Type of Tests

Exhaust emission tests were conducted according to the 1977 Federal Test Procedure (FTP) described in the Federal Register of June 28, 1977, and the EPA Highway Fuel Economy Test (HFET) described in the Federal Register of September 10, 1976. The vehicles were not tested for evaporative emissions.

Other tests were also conducted as an additional aspect of this evaluation. These tests consisted of hot start LA-4 cycles. The LA-4 driving cycle is the basic FTP driving cycle. The results of these hot start LA-4 tests are generally similar to bags 2 and 3 of the FTP.

Device Installation

Installation of the FUEL-MAX on the test vehicles was performed in accordance with the device installation instructions. Following installation, a dial on the FUEL-MAX was set for the size of the engine as specified in the instructions; i.e., set at 1.4 for the Pinto (140 CID), 2.3 for the Cutlass (231 CID), and 3.0 for the Zephyr (302 CID).

The following problems were experienced during the installations:

1. On the Pinto, the installation instructions call for the EGR valve to be disconnected from the intake manifold, but to be left connected to the exhaust gas transfer pipe so as to close the end of the transfer pipe. On the test vehicle, the EGR valve and the exhaust gas transfer pipe had to be removed because the configuration of the EGR valve was different than that shown in the installation instructions and an exhaust leak occurred.

2. On the Zephyr, the FUEL-MAX caused an exhaust leak at the manifold where the EGR valve is normally installed. A sealing plate and additional gaskets had to be employed to prevent this underhood exhaust leak.

Vehicle Test Configurations

Baseline testing was performed after each vehicle was set to the vehicle manufacturer's tune-up specifications. The second test configuration was with the FUEL-MAX installed in accordance with the installation instructions. A third configuration was employed in testing the Pinto. In this configuration (along with the FUEL-MAX), the ignition was retarded by 5° from specifications. This was done to correct the heavy knock which had been exhibited in the road evaluation.

Test Results

The vehicles were tested during March of 1981. All tests were performed by EPA at its Motor Vehicle Emission Laboratory in Ann Arbor. Table 1 summarizes the results of this testing. Emission levels are listed in grams/mile while fuel economy is shown in miles per gallon. The results of the individual tests on each vehicle are presented in Appendices B, C, and D.

Table 1
Summary of Test Results

		FTP				HFET			
Vehicle	Configuration	HC	CO	NOx	MPG	HC	CO	NOx	MPG
Ford Pinto	Baseline	2.08	26.0	1.35	21.5	.76	5.2	2.38	29.0
	FUEL-MAX	1.58	18.6	6.03	22.4	.61	2.8	6.83	29.3
	Average Change	-24%	-28%	+350%	+4.2%	-20%	-46%	+190%	+1.0%
Oldsmobile Cutlass	Baseline	1.89	21.0	1.55	18.2	.40	4.7	1.56	26.4
	FUEL-MAX	1.46	19.4	7.44	18.5	.23	1.6	8.72	26.4
	Average Change	-23%	-8.0%	+380%	+1.6%	-43%	-66%	+460%	-0-
Mercury Zephyr	Baseline	2.47	25.5	0.67	15.2	.89	2.7	1.17	22.9
	FUEL-MAX	2.08	14.2	7.17	15.7	.83	1.2	9.03	22.8
	Average Change	-16%	-44%	+970%	+3.3%	-7.0%	-5.6%	+670%	-0.4%
Overall Fleet	Baseline	2.15	24.2	1.19	17.9	.68	4.2	1.70	25.8
	FUEL-MAX	1.71	17.4	6.88	18.5	.56	1.8	8.19	25.9
	Average Change	-20%	-28%	+480%	+3.4%	-18%	-57%	+380%	+0.4%

The Pinto exhibited heavy knock during the road evaluation. In this case, the basic timing was retarded 5° and the vehicle was retested. The results are shown in Table 2 below:

Table 2
Summary of Test Results on Pinto with Retarded Timing

		FTP				HFET			
Vehicle	Configuration	HC	CO	NOx	MPG	HC	CO	NOx	MPG
Ford Pinto	Baseline	2.08	26.0	1.35	21.5	.76	5.2	2.38	29.0
	FUEL-MAX	1.58	18.6	6.03	22.4	.61	2.8	6.83	29.3
	FUEL-MAX (-5°)	1.20	18.3	4.46	22.2	.50	2.0	5.24	29.8
	Average Change (from baseline)	-42%	-30%	+230%	+3.3%	-34%	-62%	+120%	+2.8%

On-Road Evaluations and Observations

Pinto: With FUEL-MAX installed, the vehicle exhibited the following knock characteristics;

a) Cold engine, light acceleration - moderate knock
b) Heavy knock on light accelerations or while maintaining speed on a minor grade
c) Under wide-open throttle accelerations to 55 mph, knock did not occur
d) Idle quality was poor (rough) with a warmed-up engine

Ignition timing retard of approximately 5° removed the knock. Vehicle acceleration performance deteriorated.

Cutlass: With FUEL-MAX, this vehicle exhibited stumble and hesitation attributable to a lean air/fuel mixture. Knock (trace) occurred under heavy accelerations, moderate accelerations and light accelerations. Intermittant, light knock occurred under highway cruise conditions with FUEL-MAX.

Zephyr: This vehicle exhibited occasional occurrences of trace knock. When cold, the vehicle exhibited stumble at 20 mph.

Conclusions

As a result of EPA testing of FUEL-MAX on three 1979 passenger cars, the following conclusions were drawn:

1. The installation instructions and the material packaged with the device were not adequate in all cases.

2. Use of the FUEL-MAX resulted in a decrease in hydrocarbon emissions. The average decrease was 20% for the FTP and 18% for the HFET.

3. Carbon monoxide emissions were also reduced; 28% over the FTP and 57% over the HFET.

4. NOx emissions increased substantially; 480% over the FTP and 380% over the HFET.

5. Use of the FUEL-MAX resulted in a three percent increase in fuel economy on the FTP but essentially no change on the HFET.

6. During the road evaluations, FUEL-MAX caused heavy knock on one car, and light knock in another. Knock was rarely noted on the third car.

7. Installation of the FUEL-MAX device is considered "tampering" under the provisions of the Clean Air Act*.

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*"EPA tests showed that the use of this device, on the vehicles tested caused emissions to exceed applicable standards. Thus, the installation of this device by a person in the business of servicing, repairing, selling, leasing, or trading motor vehicles, fleet operators, or new car dealers will be considered in violation of Section 203(a)(3) of the Clean Air Act, the Federal prohibition against tampering with emission control systems. That is, there is currently no reasonable basis for believing that the installation or use of this device will not adversely affect emission performance. This determination does not preclude the use of the FUEL-MAX device on a different vehicle or vehicles than those tested by EPA if Federal Test Procedure tests performed on such vehicles clearly establish that emission performance of those particular vehicles is not adversely affected.

Appendix A

Test Vehicle Descriptions

Make/Model	Ford Pinto	Oldsmobile Cutlass	Mercury Zephyr
Model Year	1979	1979	1979
Type	2 door	2 door	2 door
Vehicle I.D.	9T11Y186165	3R47A9M523280	9E35F621630
Initial Odometer	23540	34880	31760
Engine Type	Spark Ignition	Spark Ignition	Spark Ignition
Configuration	In-line 4	V6	V8
Displacement	140 CID	231 CID	302 CID
Fuel Metering	2V Carburetor	2V Carburetor	2V Carburetor
Fuel Requirement	Unleaded	Unleaded	Unleaded
Transmission	Automatic	Automatic	Automatic
Tires	B78-13	P195/75R14	CR78-14
Inertia Weight	3000	4000	3500
Actual HP @50 mph	10.3	12.0	11.2
Emission Control Systems	EGR Catalyst	EGR Catalyst	EGR Air Pump Catalyst

Appendix B

Test Results - Ford Pinto, 140 CID, 4 Cylinder

Test Date.	Test #	Configuration	Federal Test Procedure HC	CO	NOx	MPG	Highway Fuel Economy Test HC	CO	NOx	MPG
3-3-81	5560	Baseline	2.09	26.1	1.37	21.44				
3-3-81	5561	Baseline					0.74	5.0	2.35	28.87
3-4-81	5562	Baseline	2.06	26.0	1.33	21.56				
3-4-81	5563	Baseline					0.77	5.3	2.40	29.19
3-5-81	5564	FUEL-MAX	1.66	20.2	5.84	22.06				
3-5-81	5565	FUEL-MAX					0.64	3.2	6.57	29.17
3-6-81	5566	FUEL-MAX	1.50	17.0	6.22	22.71				
3-6-81	5567	FUEL-MAX					0.58	2.3	7.08	29.42
3-25-81	5568	Fuel Max (-5°)*	1.00	18.8	4.36	21.97				
3-25-81	5569	Fuel Max (-5°)					0.49	1.9	4.93	29.80
3-26-81	5570	Fuel Max (-5°)	1.41	17.8	4.56	22.48				
3-26-81	5571	Fuel Max (-5°)					0.51	2.1	5.56	29.90

*For this series of tests, the device remained in place but the basic timing was retarded 5° to correct a heavy knock condition.

Appendix C

Test Results - Oldsmobile Cutlass, 231CID, V-6

Test Date.	Test #	Configuration	Federal Test Procedure HC	CO	NOx	MPG	Highway Fuel Economy Test HC	CO	NOx	MPG
3-4-81	6845	Baseline	1.95	22.3	1.56	18.16				
3-4-81	6848	Baseline					0.55	7.1	1.52	26.17
3-5-81	6849	Baseline	1.82	20.3	1.52	18.37				
3-5-81	6850	Baseline					0.43	5.0	1.44	26.61
3-6-81	6851	Baseline	1.90	20.5	1.57	18.16				
3-6-81	6852	Baseline					0.36	4.2	1.58	26.34
3-10-81	6853	FUEL-MAX	1.40	18.9	7.44	18.43				
3-10-81	6854	FUEL-MAX					0.22	1.4	8.57	26.32
3-11-81	6855	FUEL-MAX	1.51	20.0	7.45	18.62				
3-11-81	6856	FUEL-MAX					0.24	1.6	8.76	26.53
3-19-81	8359	Baseline					0.40	4.6	1.61	26.43
3-19-81	8361	Baseline					0.25	2.6	1.63	26.40
3-19-81	6858	FUEL-MAX					0.23	1.9	8.82	26.42
		HOT START LA-4								
3-19-81	8358	Baseline	1.14	13.4	1.50	19.25				
3-19-81	8360	Baseline	1.32	15.1	1.54	19.54				
3-19-81	6857	FUEL-MAX	1.24	16.5	7.90	19.71				
3-19-81	6859	FUEL-MAX	1.37	15.6	7.73	13.06*				

*Fuel economy void - error in CO_2 readings.

Appendix D

Test Results - Mercury Zephyr, 302CID, V-8

Test Date.	Test #	Configuration	Federal Test Procedure HC	CO	NOx	MPG	Highway Fuel Economy Test HC	CO	NOx	MPG
3-3-81	6771	Baseline	2.42	25.2	0.66	15.10				
3-3-81	6772	Baseline					0.94	1.4	1.34	23.08
3-4-81	6773	Baseline	2.42	24.1	0.69	15.25				
3-4-81	6774	Baseline					0.86	3.8	1.07	22.58
3-5-81	6775	Baseline	2.46	23.2	0.71	15.23				
3-5-81	6776	Baseline					0.86	2.8	1.11	23.09
3-10-81	8094	FUEL-MAX	2.05	14.3	7.20	15.72				
3-10-81	8095	FUEL-MAX					0.81	1.2	9.31	22.77
3-11-81	8125	FUEL-MAX	2.12	14.2	7.14	15.72				
3-11-81	8126	FUEL-MAX					0.85	1.1	8.75	22.80
3-18-81	8302	Baseline	2.58	29.5	0.61	15.04				

Attachment H

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Based on an evaluation of the test results submitted to support the claims for the FUEL-MAX, EPA chose to conduct confirmatory testing. The basic purpose of the testing was to determine the effect of the device on fuel economy and exhaust emissions. Secondary purposes included an evaluation of the installation instructions and driveability factors.

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Three typical 1979 production vehicles were used: a Ford Pinto with a 4-cylinder engine, an Oldsmobile Cutlass with a 6 cylinder engine, and a Mercury Zephyr with an 8 cylinder engine. All vehicles were equipped with automatic transmissions. A more detailed description of each vehicle is provided in Appendix A.

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Commercial, unleaded regular fuel was used in the testing of the FUEL-MAX. A single batch of the fuel was purchased and stored at the EPA. The motor octane number was 83 while the research octane number was 91. The decision to use a commercial fuel was based upon the knock sensitivity of some engines to EGR deactivation. The Indolene fuel used in EPA testing has a higher octane rating than typical commercial unleaded gasoline. Thus, use of commercial fuel was appropriate for this evaluation where the possibility of increased knock was probable.

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The following problems were experienced during the installations:

1. On the Pinto, the installation instructions call for the EGR valve to be disconnected from the intake manifold, but to be left connected to the exhaust gas transfer pipe so as to close the end of the transfer pipe. On the test vehicle, the EGR valve and the exhaust gas transfer pipe had to be removed because the configuration of the EGR valve was different than that shown in the installation instructions and an exhaust leak occurred.

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Vehicle Test Configurations

Baseline testing was performed after each vehicle was set to the vehicle manufacturer's tune-up specifications. The second test configuration was with the FUEL-MAX installed in accordance with the installation instructions. A third configuration was employed in testing the Pinto. In this configuration (along with the FUEL-MAX), the ignition was retarded by 5° from specifications. This was done to correct the heavy knock which had been exhibited in the road evaluation.

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The vehicles were tested during March of 1981. All tests were performed by EPA at its Motor Vehicle Emission Laboratory in Ann Arbor. Table 1 summarizes the results of this testing. Emission levels are listed in grams/mile while fuel economy is shown in miles per gallon. The results of the individual tests on each vehicle are presented in Appendices B, C, and D.

Table 1
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	Average Change	-23%	-8.0%	+380%	+1.6%	-43%	-66%	+460%	-0-
Mercury Zephyr	Baseline	2.47	25.5	0.67	15.2	.89	2.7	1.17	22.9
	FUEL-MAX	2.08	14.2	7.17	15.7	.83	1.2	9.03	22.8
	Average Change	-16%	-44%	+970%	+3.3%	-7.0%	-5.6%	+670%	-0.4%
Overall Fleet	Baseline	2.15	24.2	1.19	17.9	.68	4.2	1.70	25.8
	FUEL-MAX	1.71	17.4	6.88	18.5	.56	1.8	8.19	25.9
	Average Change	-20%	-28%	+480%	+3.4%	-18%	-57%	+380%	+0.4%

The Pinto exhibited heavy knock during the road evaluation. In this case, the basic timing was retarded 5° and the vehicle was retested. The results are shown in Table 2 below:

Table 2
Summary of Test Results on Pinto with Retarded Timing

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	FUEL-MAX (-5°)	1.20	18.3	4.46	22.2	.50	2.0	5.24	29.8
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On-Road Evaluations and Observations

Pinto: With FUEL-MAX installed, the vehicle exhibited the following knock characteristics;

a) Cold engine, light acceleration - moderate knock
b) Heavy knock on light accelerations or while maintaining speed on a minor grade
c) Under wide-open throttle accelerations to 55 mph, knock did not occur
d) Idle quality was poor (rough) with a warmed-up engine

Ignition timing retard of approximately 5° removed the knock. Vehicle acceleration performance deteriorated.

Cutlass: With FUEL-MAX, this vehicle exhibited stumble and hesitation attributable to a lean air/fuel mixture. Knock (trace) occurred under heavy accelerations, moderate accelerations and light accelerations. Intermittant, light knock occurred under highway cruise conditions with FUEL-MAX.

Zephyr: This vehicle exhibited occasional occurrences of trace knock. When cold, the vehicle exhibited stumble at 20 mph.

Conclusions

As a result of EPA testing of FUEL-MAX on three 1979 passenger cars, the following conclusions were drawn:

1. The installation instructions and the material packaged with the device were not adequate in all cases.

2. Use of the FUEL-MAX resulted in a decrease in hydrocarbon emissions. The average decrease was 20% for the FTP and 18% for the HFET.

3. Carbon monoxide emissions were also reduced; 28% over the FTP and 57% over the HFET.

4. NOx emissions increased substantially; 480% over the FTP and 380% over the HFET.

5. Use of the FUEL-MAX resulted in a three percent increase in fuel economy on the FTP but essentially no change on the HFET.

6. During the road evaluations, FUEL-MAX caused heavy knock on one car, and light knock in another. Knock was rarely noted on the third car.

7. Installation of the FUEL-MAX device is considered "tampering" under the provisions of the Clean Air Act*.

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*"EPA tests showed that the use of this device, on the vehicles tested caused emissions to exceed applicable standards. Thus, the installation of this device by a person in the business of servicing, repairing, selling, leasing, or trading motor vehicles, fleet operators, or new car dealers will be considered in violation of Section 203(a)(3) of the Clean Air Act, the Federal prohibition against tampering with emission control systems. That is, there is currently no reasonable basis for believing that the installation or use of this device will not adversely affect emission performance. This determination does not preclude the use of the FUEL-MAX device on a different vehicle or vehicles than those tested by EPA if Federal Test Procedure tests performed on such vehicles clearly establish that emission performance of those particular vehicles is not adversely affected.

Appendix A

Test Vehicle Descriptions

Make/Model	Ford Pinto	Oldsmobile Cutlass	Mercury Zephyr
Model Year	1979	1979	1979
Type	2 door	2 door	2 door
Vehicle I.D.	9T11Y186165	3R47A9M523280	9E35F621630
Initial Odometer	23540	34880	31760
Engine Type	Spark Ignition	Spark Ignition	Spark Ignition
Configuration	In-line 4	V6	V8
Displacement	140 CID	231 CID	302 CID
Fuel Metering	2V Carburetor	2V Carburetor	2V Carburetor
Fuel Requirement	Unleaded	Unleaded	Unleaded
Transmission	Automatic	Automatic	Automatic
Tires	B78-13	P195/75R14	CR78-14
Inertia Weight	3000	4000	3500
Actual HP @50 mph	10.3	12.0	11.2
Emission Control Systems	EGR Catalyst	EGR Catalyst	EGR Air Pump Catalyst

Appendix B

Test Results - Ford Pinto, 140 CID, 4 Cylinder

Test Date.	Test #	Configuration	Federal Test Procedure HC	CO	NOx	MPG	Highway Fuel Economy Test HC	CO	NOx	MPG
3-3-81	5560	Baseline	2.09	26.1	1.37	21.44				
3-3-81	5561	Baseline					0.74	5.0	2.35	28.87
3-4-81	5562	Baseline	2.06	26.0	1.33	21.56				
3-4-81	5563	Baseline					0.77	5.3	2.40	29.19
3-5-81	5564	FUEL-MAX	1.66	20.2	5.84	22.06				
3-5-81	5565	FUEL-MAX					0.64	3.2	6.57	29.17
3-6-81	5566	FUEL-MAX	1.50	17.0	6.22	22.71				
3-6-81	5567	FUEL-MAX					0.58	2.3	7.08	29.42
3-25-81	5568	Fuel Max (-5°)*	1.00	18.8	4.36	21.97				
3-25-81	5569	Fuel Max (-5°)					0.49	1.9	4.93	29.80
3-26-81	5570	Fuel Max (-5°)	1.41	17.8	4.56	22.48				
3-26-81	5571	Fuel Max (-5°)					0.51	2.1	5.56	29.90

*For this series of tests, the device remained in place but the basic timing was retarded 5° to correct a heavy knock condition.

Appendix C

Test Results - Oldsmobile Cutlass, 231CID, V-6

Test Date.	Test #	Configuration	Federal Test Procedure HC	CO	NOx	MPG	Highway Fuel Economy Test HC	CO	NOx	MPG
3-4-81	6845	Baseline	1.95	22.3	1.56	18.16				
3-4-81	6848	Baseline					0.55	7.1	1.52	26.17
3-5-81	6849	Baseline	1.82	20.3	1.52	18.37				
3-5-81	6850	Baseline					0.43	5.0	1.44	26.61
3-6-81	6851	Baseline	1.90	20.5	1.57	18.16				
3-6-81	6852	Baseline					0.36	4.2	1.58	26.34
3-10-81	6853	FUEL-MAX	1.40	18.9	7.44	18.43				
3-10-81	6854	FUEL-MAX					0.22	1.4	8.57	26.32
3-11-81	6855	FUEL-MAX	1.51	20.0	7.45	18.62				
3-11-81	6856	FUEL-MAX					0.24	1.6	8.76	26.53
3-19-81	8359	Baseline					0.40	4.6	1.61	26.43
3-19-81	8361	Baseline					0.25	2.6	1.63	26.40
3-19-81	6858	FUEL-MAX					0.23	1.9	8.82	26.42
		HOT START LA-4								
3-19-81	8358	Baseline	1.14	13.4	1.50	19.25				
3-19-81	8360	Baseline	1.32	15.1	1.54	19.54				
3-19-81	6857	FUEL-MAX	1.24	16.5	7.90	19.71				
3-19-81	6859	FUEL-MAX	1.37	15.6	7.73	13.06*				

*Fuel economy void - error in CO_2 readings.

Appendix D

Test Results - Mercury Zephyr, 302CID, V-8

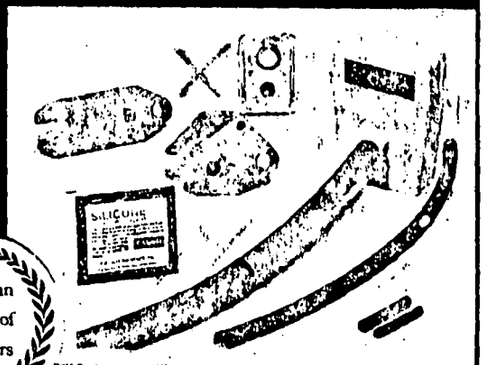
Test Date.	Test #	Configuration	Federal Test Procedure HC	CO	NOx	MPG	Highway Fuel Economy Test HC	CO	NOx	MPG
3-3-81	6771	Baseline	2.42	25.2	0.66	15.10				
3-3-81	6772	Baseline					0.94	1.4	1.34	23.08
3-4-81	6773	Baseline	2.42	24.1	0.69	15.25				
3-4-81	6774	Baseline					0.86	3.8	1.07	22.58
3-5-81	6775	Baseline	2.46	23.2	0.71	15.23				
3-5-81	6776	Baseline					0.86	2.8	1.11	23.09
3-10-81	8094	FUEL-MAX	2.05	14.3	7.20	15.72				
3-10-81	8095	FUEL-MAX					0.81	1.2	9.31	22.77
3-11-81	8125	FUEL-MAX	2.12	14.2	7.14	15.72				
3-11-81	8126	FUEL-MAX					0.85	1.1	8.75	22.80
3-18-81	8302	Baseline	2.58	29.5	0.61	15.04				

Award Winning Automotive Engineers MAKE BREAKTHROUGH SLASH GAS CONSUMPTION with FUEL MAX

Tests prove Savings up to 12½ mpg (city) Up to 33% mpg (highway)

DEVELOPED BY THE INVENTORS OF THE YEAR 1979

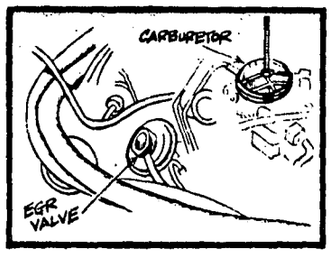
American Society of Inventors

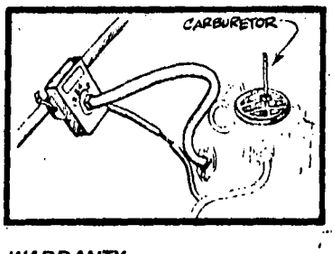


What is Fuel Max? *Pollution control systems, used on cars built since 1973 to help meet Federal emissions control standards, drive down gas mileage and performance. Fuel Max* is a precision engineered device that enables a car owner to change the air/fuel ratio and eliminate the negative effects of exhaust gas recirculation. Fuel Max can add up to 12½%** more mpg in city driving, up to 33%** more on the highway. When Fuel Max was tested on 50 randomly selected '73 to '79 cars and trucks, gas savings averaged a dramatic 10½%! Fuel Max also saves gas and improves performance on 1980 models, but to a lesser degree.*

How does Fuel Max work? ***The pollution control system on '73—'80 automobiles works by recirculating exhaust gas back into the engine by means of an EGR (Exhaust Gas Recirculating) Valve. This reduces the exhaust emissions but also decreases the car's smoothness, acceleration and response. It causes more gas to be burned. Fuel Max is a precision built vacuum operated valve that uses the existing EGR system but allows MORE AIR into the engine intake and eliminates recirculation of exhaust gas. More air in the combustible mixture means a leaner mix—you use less gas, get better performance, and lower total overall emissions.***

Fuel Max is easy to install. *Easy-to-follow instructions included—simpler than changing your car's sparkplugs.*
No carburetor adjustment necessary!
Federal EPA regulations permit vehicle owner to install Fuel Max on own vehicle.





Only $29.95 *postpaid right to your door. Fuel Max soon pays for itself with the gas savings you get! Exclusive only through this offer.*

Order today. *Start saving gas and getting better performance from your car.*

*Patent pending
**Results of tests using E.P.A. procedures on a 1977 Chevy with a 305 cubic inch V-8 engine.

WARRANTY
Fuel Max is warranted against defects in materials and workmanship for one year from date of purchase.

OGI Group Ltd.
114 East 32 Street
New York, New York 10016

Please send me — FUEL MAX @ $29.95 ppd.

Name _____

Address _____

City _____ *State* _____ *Zip* _____

*Enclosed is my check or money order for $*_____

Visa & Mastercharge card holders dial toll free #800-228-2028

Satisfaction Guaranteed or Money Refunded

13. Will I Really Save Gas by Driving 55 MPH instead of 60 or 65?

Yes. The most efficient driving speed is usually between 30 and 40 miles per hour. For each 10 mph speed increase,there is a fuel economy penalty of about 10 percent. At speeds above 65 mph, the penalty is even greater.

14. Does the Air Conditioner Reduce Fuel Economy?

Yes. The air conditioner uses engine power, which causes a decrease in fuel economy of a few percent.

15. Why Do Some Cars Run after They Are Turned Off?

After-Run, or so-called dieseling, is aggravated by an excessively fast idle speed. Engines should be tuned when warmed up to idle at the minimum speed which gives a smooth idle. (Check automatic transmission cars in "drive".) If cold idling is a problem, the automatic choke may be set to stay on longer. (Automatic choke also boosts idle speed.)

16. Is There Really a Fuel Shortage?

Yes and No. There is no shortage of energy resources, but there is a very real shortage of cheap energy. We have become accustomed to buying gasoline for 50¢ per gallon, which is less than we pay for beer, milk, soft drinks, or even distilled water.

17. What Kind of Tires Give the Best Gas Mileage?

Radial tires have less rolling resistance than bias-ply tires, and give a fuel economy improvement of a few percent. Higher tire pressures can also add a few percent to fuel economy, but safety is more important. Stick to the manufacturer's recommened tire pressures.

18. Do Special Oils Really Work?

Some of the synthetic oil products and "slippery" oils can make a small improvement in fuel economy by reducing engine friction.

19. Is It Legal for Me to Change My Car's Emission Control System?

If you are not a Professional Mechanic, Dealer Representative, or Fleet Operator, the Federal EPA Laws do not apply to you. Some individual states are considering legislation which might apply. Check your owns state's legislation if you are not sure.

20. Can Fuel-Max Damage an Engine?

No. Fuel-Max can actually prolong the life of an engine by eliminating the corrosive effect of exhaust gas recirculation.

P. O. Box 726
Bellmawr, NJ 08031

FUEL-MAX

FUEL-MAX — GASOLINE CONSERVATION FOR CARS AND TRUCKS

Fuel-Max has been designed for the motorist who wants to improve his vehicle's fuel economy. The Fuel-Max installation has shown an average improvement in fuel economy better than ten percent. For those serious about conserving fuel, an additional ten to twenty percent may be saved by careful attention to driving habits.

Driving Habits can make the difference between 15 MPG and 25 MPG on the same car. Careful use of your car's power can save more fuel than any other technique.

Most of the gasoline your car uses is consumed during accelerations. The harder you accelerate, the more fuel is wasted. It is for this reason that highway driving gives better economy than city driving.

While only about 10 horsepower are needed to maintain your car at 55 miles per hour on the highway, you can use all of your engine's horsepower to accelerate. The economical driver uses the minimum horsepower required for any driving situation. A good way to retrain yourself for economical driving habits is to pretend there is a glass of water on the dashboard, and drive in such a way as to avoid getting wet.

REMEMBER THESE GAS-SAVING TIPS —

- **AVOID PROLONGED IDLING**
- **DON'T CARRY AROUND UNNECESSARY WEIGHT**
- **ACCELERATE GRADUALLY, DRIVE SMOOTHLY**
- **FOLLOW THE SPEED LIMITS — HIGHER SPEEDS WASTE FUEL**

FUEL ECONOMY — QUESTIONS AND ANSWERS

To help you understand some of the technical aspects, we have listed answers to the 20 most frequently asked questions about fuel economy.

1. What is EGR? (Exhaust Gas Recirculation)
Exhaust Gas Recirculation is used on all cars built after 1973. The EGR Valve is controlled by a vacuum signal that comes from the carburetor whenever the throttle is in the cruising range. Most cars also have a temperature-controlled vacuum switch in the control line to keep the EGR Valve from opening when the engine is cold.

EGR allows some of the exhaust gas to bleed back into the engine intake, which helps to control one of the emissions, Oxides of Nitrogen. When the EGR system is disconnected, fuel economy improves a few percent, performance is improved noticeably, Oxides of Nitrogen emissions increase, and the engine may knock or ping more than before.

Fuel-Max uses the controls and passages of the EGR system for another purpose.

2. How does the Fuel-Max work?
Fuel-Max makes use of an engine's existing EGR system, but bleeds air into the engine instead of exhaust gas. The Fuel-Max improves fuel economy and performance, and causes a change in the balance of the three regulated exhaust emissions. In general, Hydrocarbon and Carbon Monoxide emissions go down, and Oxides of Nitrogen emissions go up. The total of the three emissions usually goes down.

Fuel-Max causes the engine to run on a leaner air-fuel mixture, only when the engine is warmed up. Fuel-Max does not operate at idle, or on wide-open throttle accelerations. For this reason a better fuel economy improvement should be expected in highway driving than urban driving.

3. What is Engine Knock or Ping?
Knock is the sound made by a small "explosion" in the combustion chamber, when the fuel and air burn abruptly instead of smoothly. Heavy and prolonged knocking can cause damage to the engine. There are two remedies for excessive knock:
1. Switch to a higher octane fuel.
2. Retard the ignition timing, which will also cause the fuel economy to decrease.

4. Should I Change the Ignition Timing?
To get the maximum fuel economy, ignition timing should be advanced as far as the engine will tolerate without knocking. (Usually not more than 8 degrees beyond factory specifications.) Advanced timing will usually cause the emissions to increase.

5. What is Octane? Octane is a measure of a fuel's resistance to knock. For example, an engine which knocks on 86 octane fuel might not knock on 90 octane fuel.

6. What is Unleaded Gasoline?
Before 1975, almost all gasoline contained a Lead-Compound additive. Lead increases the octane of the gasoline, but may not be used in catalyst-equipped vehicles. The lead is deposited on the inside of the catalytic converter and spoils the catalyst.

7. Why does Unleaded cost more than Regular?
If lead is not used to boost a fuel's octane, the fuel must go through additional refining to raise its octane. The extra refining uses energy, so unleaded fuel costs more to manufacture than leaded fuel of the same octane.

8. What is Air-Fuel Ratio?
The mixture of fuel and air supplied by the carburetor or fuel injection system must be carefully set to the right ratio. Most vehicles operate in the range of 15 to 18 Air-Fuel Ratio. (15 pounds of air for each pound of fuel.)

The most efficient mixture is the leanest (highest air-fuel ratio) that the engine will tolerate without rough running or hesitation. There is no external adjustment on the carburetor for air-fuel ratio, except the idle mixture.

9. How Should I Adjust the Idle Mixture?
Turn the mixture screw (or screws) to the leanest setting (clockwise is leaner) that gives a smooth idle. Some cars have plastic limiter caps on the idle screws to restrict the range of adjustment.

10. Will a Lean Mixture "Burn Valves"?
No. All modern cars operate at air-fuel ratios greater than 15. The air-fuel ratio which gives the highest combustion temperature is 14.7. Temperatures drop as the mixture gets richer or leaner than 14.7.

Before 1970, many vehicles used mixtures richer than 14.7, and leaning the mixture could raise combustion temperatures, and "burn valves".

11. Will it help to remove the Catalytic Converter?
No. The catalytic converter has no direct effect on fuel economy. Its removal would not produce any change except increased exhaust emissions.

12. How Should I Measure Gas Mileage?
Anyone can measure fuel economy by keeping a record of each fuel purchase. Start by noting the odometer reading when the tank is full. Then note the number of miles on the odometer and the gallons purchased every time you buy fuel. After using several tankfuls of fuel, divide the total miles travelled by the total gallons used. The result will be the miles per gallon. Be sure to average several tankfuls of fuel, to get accurate measurements over a long period.

Attachment K

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

November 7, 1980

Mr. Michael D. Leshner, Chief Engineer
FIDCO Fuel Injection Development Corporation
110 Harding Avenue
Bellmaur, NJ 08030

Dear Mr. Leshner:

During our analysis of your firm's application for evaluation of the "Fuel-Max" fuel economy retrofit device under Section 511 of the Motor Vehicle Information and Cost Savings Act we have found deficiencies in the data you enclosed with your application.

First, the appendices to one of the Scott reports were not included with the application. We requested a complete copy of the report from Scott Environmental Technology, Inc. but they will not release the information to us without prior authorization from the sponsoring company. Please forward to us Appendices A, B, and C for Scott Report #1827 01 0979, "Technical Report on Evaluation of a Fuel Economy Device".

Second, in the test reports provided with your firm's application, the baseline data were collected by the testing laboratory on vehicles in an "as received" condition. The independent laboratory can not verify the status of the engine design parameter settings. Please provide detailed information regarding the engine design parameter settings (ignition timing, idle speed, idle mixture, etc.) for each vehicle used for the baseline and device installed testing supporting your firm's application for evaluation.

Thank you very much for your help on this problem. Your cooperation will facilitate the evaluation process.

Sincerely,

Merrill W Korth

Merrill W. Korth, EPA Device Evaluation Coordinator
Test and Evaluation Branch

Received 1/5/81
Attachment L

FIDCO Fuel Injection Development Corporation

29 December 1980

Mr. Merrill W. Korth
U.S. Environmental Protection Agency
Ann Arbor, Michigan 48105

Dear Mr. Korth,

I have enclosed a complete copy of Scott Environmental Technology Report #1827 01 0979. The copy which was originally sent with our Section 511 Application did not include the appendices. These appendices were not available to our company until today. The company which sponsored the test program was not willing to share the appendices without compensation, and we had to negotiate a special agreement for their release.

Second, we did some checking on the engine design parameter settings for the test vehicles. All of the vehicles were leased by the sponsoring company for their employees. The vehicles were all delivered new by factory dealerships, and were not adjusted after initial new-car preparation. Since these calibrations were not measured, we can only assume they were all set to factory specifications.

I apologize for the delay in forwarding this information. Please let me know if I can help you to expedite this evaluation.

Sincerely,

Michael D. Leshner

Michael D. Leshner
Chief Engineer

110 Harding Avenue • Bellmawr, N.J. 08030 • 609/931-3168