

Retro-fit Emission Control Devices for Pre-1968 Vehicles

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Subject: Used Car Test Program Results

General Motors Inc., Ford Motor Co., and Chrysler Corporation have developed retro-fit devices to be applied to pre-1968 uncontrolled vehicles as a means of reducing emissions from the large population of such automobiles. Because of preliminary claims by manufacturers which created interest in state legislation, an emission test program was initiated.

Three automobiles from the HEW fleet in Ypsilanti were selected to be used as test vehicles. These cars included: a 1962 Chevrolet Biscayne with a 283 cubic inch engine and automatic transmission, a 1963 Chevrolet Impala with a 283 cubic inch engine and standard transmission, and a 1963 Ford Galaxie with a 289 cubic inch engine and automatic transmission. For the series of tests Indolene 30 was used and fuel consumption was measured for each test by weighing the test fuel tank before and after each run. All tests were cold start.

The following tests were performed on both the uncontrolled vehicle tuned to recommended manufacturer specifications and on the same vehicle after installation of the retro-fit device according to the instructions supplied with the devices.

1. 1968 Federal procedure for exhaust emissions (FTP).
2. 9 cycles of the 7-mode Federal cycle used with constant volume sampling (CVS).
3. Proposed 1972 LA4-S3 test cycle with constant volume sampling (CVS).

The 1968 Federal procedure data were obtained with NDIR instruments while both NDIR and FID instruments were used in the CVS technique. The Whittaker "NO_x Box" was used for determination of oxides of nitrogen in the CVS sample.

The General Motors device was tested on all three cars while the Ford device which is designed only for Ford products was tested only on the Ford Galaxie. The 1962 Chevrolet Biscayne was tested both with a stock carburetor and a lean limit carburetor.

Dynamometer Results

Actual emission levels for the various configurations tested are shown in the appendix to this report. Included in these results are the fuel consumptions obtained for each test.

GM Device

Table I shows the percent reduction of hydrocarbon, carbon monoxide, and nitric oxide emissions for the four vehicle configurations. As is shown, using the 1968 Federal procedure the average reductions are: 54% less hydrocarbons, 24% less carbon monoxide, and 29% less nitric oxide. Using the 9 cycle CVS test the average reductions change to 37% less hydrocarbons, 19% less carbon monoxide, and 20% less nitric oxides. Using the 1972 proposed Federal procedure reductions were 35% less hydrocarbons, 14% less carbon monoxide and 16% less nitric oxide.

It should be noted that in two cases the constant volume sampling technique indicated an increase in carbon monoxide and nitric oxide with the device installed. This occurred with the 1963 Chevrolet Impala being tested by the 9 cycle CVS test and with the 1962 Chevrolet Biscayne (with lean carburetor) being tested by the proposed 1972 Federal procedure.

Ford Device

Table II indicates the percent reduction in levels of emissions for hydrocarbon, carbon monoxide, and nitric oxide for the 1963 Ford Galaxie with the Ford device attached. As indicated with the 1968 Federal procedure hydrocarbon was reduced 66%, carbon monoxide 39%, and nitric oxide 57%. With 9 cycle CVS hydrocarbon was reduced by 39%, carbon monoxide increased 9%, and nitric oxide decreased 33%. Using the 1972 proposed Federal procedure hydrocarbon was decreased by 58%, carbon monoxide 27% and nitric oxide 16%.

Fuel Consumption

GM Device

Table I shows the relative change in gasoline consumption caused by the attachment of the General Motors device. On the 1968 Federal test procedure (and necessarily the 9 cycle CVS) the average fuel consumption was increased 8% with the kit. An average 6% increase was measured by testing with the proposed 1972 Federal procedure.

Ford Device

Table II indicates that attachment of the Ford device caused a 27% increase and a 6% increase using the 1968 and 1972 Federal procedures respectively.

Driveability Effects

Certain qualitative effects on performance were noticed by the test personnel during the running of the test cycles. With installation of the General Motors device the car lost a small but noticeable degree of responsiveness. The effect of application of the Ford device was more severe. The car had a tendency to surge at constant loads. In addition full throttle accelerations were needed to match the cycle acceleration requirement. This was not necessary at all for the uncontrolled vehicle.

Summary of Results

1. Emissions of all three pollutants, hydrocarbon, carbon monoxide, and nitric oxide, on the average were decreased by the application of a retro-fit device. The constant volume sampling technique used both in the 9 cycle and 1972 Federal procedure showed considerably smaller reduction than did the 1968 Federal procedure.

Comparison of 1968 FTP and 1972 FTP Results

GM Device

	<u>1968 % Reduction</u>	<u>1972 % Reduction</u>
Hydrocarbon	54%	35%
Carbon Monoxide	24	14
Nitric Oxide	29	16

Ford Device

	<u>1968 % Reduction</u>	<u>1972 % Reduction</u>
Hydrocarbon	66%	58
Carbon Monoxide	39	27
Nitric Oxide	57	16

The several increases in carbon monoxide and/or nitric oxide with the device attached indicate that the real effectiveness of the device on some vehicle configurations is marginal.

2. Since all tests showed either no appreciable change or an increase in fuel consumption, it is obvious that one of the penalties of the devices will be increased operating costs.

3. Attachment of a retro-fit device does decrease the vehicles performance, in one case an intolerable amount.

TABLE I

GM Retro-Fit Device
Percent Reductions*

	<u>'63 Chevy Impala</u>	<u>'63 Ford Galaxie</u>	<u>'62 Chevy Biscayne (stock carb)</u>	<u>'62 Chevy Biscayne (lean carb)</u>	<u>Average</u>
<u>'68 Procedure</u>					
HC	64%	61%	43%	48%	54%
CO	6	25	37	28	24
NO	45	41	1	28	29
Fuel	19 inc.	6 inc.	6 inc.	0	8 inc.
<u>1 Cycle CVS</u>					
HC	29	46	39	35	37
CO	16 inc.	21	25	14	19
NO	21 inc.	31	2	24	20
Fuel	19 inc.	6 inc.	6 inc.	0	8 inc.
<u>72 Procedure</u>					
HC	39	49	33	20	35
CO	6	26	24	1 inc.	14
NO	12	28	22	2 inc.	16
Fuel	14 inc.	0	0	9 inc.	6 inc.

* Note: "inc." indicates increase

TABLE 11

Ford Retro-Fit Device
1963 Ford Galaxie
Percent Reduction*

'68 Procedure

HC	66%
CO	39
NO	57
Fuel	27 inc.

9 Cycle CVS

HC	39
CO	9 inc.
NO	33
Fuel	27 inc.

'72 Procedure

HC	58
CO	27
NO	16
Fuel	6 inc.

* Note: "inc." indicates increase

Appendix

Emission Test Results

GM Device

1963 Chevrolet Impala

1968 FTP		HC ppm	CO %	NO ppm	Fuel kg
Without device		909.6	3.52	371.7	1.360
		867.9	3.33	534.4	1.400
With device		317.7	3.19	263.5	1.600
		314.2	3.00	272.7	1.645
9 Cycle CVS		HC gpm	CO gpm	NO gpm	Fuel kg
Without device		11.69	75.28	1.16	1.360
		10.54	75.16	1.64	1.400
With device		7.82	86.69	1.68	1.600
		8.22	87.49	1.71	1.645
1972 FTP		HC ppm	CO %	NO ppm	Fuel kg
Without device		10.78	98.41	1.93	1.400
		10.27	98.45	1.73	1.505
With device		5.85	85.51	1.96	1.610
		7.09	98.99	1.25	1.690

1963 Ford Galaxie

1968 FTP		HC ppm	CO %	NO ppm	Fuel kg
Without device		922.7	3.81	1056.6	1.540
		954.5	3.42	926.2	1.425
With device		363.3	2.66	619.3	1.575
		372.8	2.73	548.8	1.565
9 Cycle CVS		HC gpm	CO gpm	NO gpm	Fuel kg
Without device		13.07	87.77	3.14	1.540
		13.06	78.83	3.30	1.425
With device		6.73	65.07	1.86	1.575
		7.39	66.98	2.56	1.565

1972 FTP

Without device	12.21	116.48	2.99	1.685
	13.10	137.25	2.94	1.820
With device	6.66	96.60	2.04	1.790
	6.36	91.02	2.23	1.695

1962 Chevrolet Biscayne
(stock carburetor)

1968 FTP	HC ppm	CO %	NO ppm	Fuel kg
Without device	662.5	3.96	475.7	1.630
With device	361.4	2.39	391.2	1.760
	396.7	2.61	550.4	1.710

9 Cycle CVS	HC gpm	CO gpm	NO gpm	Fuel kg
Without device	14.24	122.33	2.30	1.630
With device	8.50	82.48	2.15	1.760
	8.78	101.04	2.34	1.710

1972 FTP

Without device	8.96	132.41	2.83	1.900
	8.84	128.96	2.38	1.815
With device	5.96	106.81	1.80	1.950
	5.90	99.57	2.04	1.760

1962 Chevrolet Biscayne
(lean limit carburetor)

1968 FTP	HC ppm	CO %	NO ppm	Fuel kg
Without device	508.1	1.91	866.4	1.755
	546.8	2.02	740.7	1.500
With device	322.4	1.43	479.3	1.635
	229.4	1.41	670.9	-----

9 Cycle CVS	HC gpm	CO gpm	NO gpm	Fuel kg
Without device	8.40	53.02	2.92	1.755
	9.08	54.28	2.51	1.500
With device	5.46	38.02	1.36	1.635
	5.81	53.99	2.76	-----

1972 FTP				
	Without device	5.99	60.05	2.47
		6.49	62.90	2.70
	With device	4.41	53.21	2.56
		5.57	71.24	2.73
				1.630
				1.660
				1.800

Ford Device

1963 Ford Galaxie

1968 FTP		HC ppm	CO g	NO ppm	Fuel kg
	Without device	922.7	3.81	1056.6	1.540
		954.5	3.42	926.2	1.425
	With device	316.7	2.26	416.6	1.900
		317.9	2.13	439.1	1.860
9 Cycle CVS		HC gpm	CO gpm	NO gpm	Fuel kg
	Without device	13.07	87.77	3.14	1.540
		13.06	78.83	3.30	1.425
	With device	8.08	96.95	2.22	1.900
		7.91	84.81	2.11	1.860
1972 FTP					
	Without device	12.21	116.48	2.99	1.685
		13.10	137.23	2.94	1.820
	With device	5.63	92.07	2.46	-----
		5.04	92.98	2.50	1.860