



EPA Laboratory Evaluation of the Aftermarket Retrofit Device Tail Pipe Cat



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Vehicle Programs and Compliance Division
Office of Mobile Sources
U.S. Environmental Protection Agency

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Introduction

This report describes the U.S. Environmental Protection Agency (EPA) laboratory exhaust emission and fuel economy testing of a product named Tail Pipe Cat (TPC) by the Vehicle Programs and Compliance Division (VPCD) at EPA's National Vehicle and Fuel Emissions Laboratory (NVFEL) in Ann Arbor, Michigan. TPC is a product developed by Compliance and Research Services, Inc. which identifies itself as CARS. The testing reported here was volunteered for and paid by CARS as found in the following regulations: 42 USC 7525; 49 USC 32918; and 40 CFR 610

EPA's analysis of the independent test laboratory data furnished with the CARS application for evaluation demonstrated a statistically significant reduction in exhaust emissions when TPC was installed on the vehicles tested. CARS is also an independent test laboratory qualified to conduct EPA test protocols. They furnished test data acquired in their laboratory from testing a large volume of vehicles during the development of the TPC. However, EPA could not consider that data because CARS has a special interest in its own product and their data would not have been considered to be independently derived.

TPC is a supplemental catalytic converter intended to operate in conjunction with the existing original equipment manufacturer (OEM) converter. The purpose of this product is to further reduce the exhaust emissions of vehicles which are reaching the end of their intermediate useful life (50,000 miles as identified in their application). The initial targeted market identified by CARS in its application is for operators of large vehicle fleets such as major corporations and government organizations. CARS makes no fuel economy claims for TPC.

Although CARS has not disclosed the specific catalytic materials nor the amount of catalyst employed (catalyst loading) in their product, it should be presumed that it will be at least the same, or better, than that used in the test sample when offered to the marketplace. The TPC may also be marketed by two other names as indicated in the CARS application; these names are Aux Cat and Cat-A-Pass.

The conclusions drawn from EPA evaluation tests are necessarily of limited applicability. An all encompassing evaluation of the effectiveness of a product in achieving performance improvements on the many types of vehicles that are in actual use would require a large sample of test vehicles. This is not economically feasible in the evaluation projects conducted by EPA. Therefore, the conclusions from such tests can be considered to be quantitatively valid only for the specific test vehicles used; however, it is reasonable to extrapolate the results from EPA tests to other types of vehicles in a directional manner; i.e., to suggest that similar results are likely to be achieved on other similar types of vehicles.

Test Program

The purpose of the EPA test program was to conduct a controlled technical evaluation of TPC in a manner that would address the manufacturer's specific claims for additional reduction in exhaust emissions with the product installed in conjunction with the vehicle's existing emission control components. An invitation was extended to CARS to have a representative present for all phases of maintenance and testing at the EPA test laboratory.

The confirmatory test plan developed and conducted by EPA (see Appendix: Test Plan Agreement) and agreed to by CARS used the following two vehicles: A 1996 Dodge Caravan, Vehicle Identification Number (VIN) 1B4G44R8TB142323, Engine Family Code TCR3.328GKEK, 3.3 liter, with automatic transmission and 80,724 miles on the odometer at the start of testing. This vehicle was furnished by CARS. The second was a 1996 Ford F-150, Vehicle Identification Number (VIN) 1FTEF15N3TLA62042, Engine Family Code TFM5.088GBJK, 5.0 liter, with automatic transmission, and 17,123 miles on the odometer at the start of testing. The F-150 was furnished by EPA and came from its test vehicle lease program.

The federal certification standards, in grams per mile for each pollutant, for these model year (MY) 1996 vehicles are:

<u>Pollutant</u>	<u>5 years/50 K miles</u>	<u>11 years/120 K miles</u>
Carbon Monoxide	4.4	5.5
Oxides of Nitrogen	0.7	0.97
Non-methane Hydrocarbons	0.32	0.40

Although the two test vehicles were light duty trucks chosen for the ease of installing the TPC, this does not imply that the product may be difficult to install on other vehicle types nor that its use should be limited to light duty trucks. It was merely expedient and resource effective to use these vehicles.

Prior to testing, the test vehicles were inspected and maintenance performed identical to that employed on consumer owned vehicles in the VPCD in-use emissions program. The vehicles were tuned to manufacturer's specifications, and any malfunctioning part was replaced as necessary. Engine oil and filter change is included in the maintenance procedure. Once the testing program was started, no adjustments were made to either vehicle.

The test phases were:

1. Three Federal Test Procedure tests (FTP, the simulated city drive test) and three Highway Fuel Economy Tests (HFET) with the vehicle in stock configuration were performed to establish the emissions and fuel economy characteristics prior to the installation of TPC. No adjustments were made to any engine components between tests.

Note: Although CARS makes no fuel economy claims with use of the TPC , it is EPA policy to conduct the fuel economy tests to determine whether there are negative effects when using any device or fuel additive in the evaluation program.

2. After stock configuration testing, the TPC was installed in the exhaust downstream of the stock catalytic converter per CARS' instruction and five FTP and HFET tests were conducted to measure emissions and fuel economy. No adjustments were made to any engine components between tests.

3. After conducting the test series with the TPC installed, each vehicle was driven 1000 miles over the standard EPA driving course in the Ann Arbor, Michigan area to provide some degree of aging of the TPC.

4. An additional five FTP and HFET tests were conducted to measure emissions and fuel economy after 1000 miles were accumulated on each vehicle. No adjustments were made to any engine components between tests.

5. The TPC was removed after testing the product and another triplicate set of stock configuration tests was conducted on each vehicle. Again, no adjustments were made to any engine components between tests.

Results

All test data generated in the EPA laboratory test program are presented in Tables 1-8.

The results of the testing are shown in the three following comparisons: the results of testing after initially installing the TPC against the stock configuration, the results of testing after 1000 miles accumulation with the TPC against the stock configuration, and the results of testing after removal of the TPC and restoration to stock configuration against the stock configuration before installation of the TPC.

The emissions for both vehicles in stock configuration were below the MY 1996 federal emission standards. Although there is no federal standard for total hydrocarbons for these MY 1996 vehicles, we have provided the test results in conjunction with non-methane hydrocarbon data since CARS had furnished this data with their application.

First Installation of the TPC

The Dodge Caravan had a 17% reduction in both non-methane hydrocarbons (NMHC) and hydrocarbons (HC), a 30% reduction in carbon monoxide (CO), and a 38% reduction in oxides of nitrogen (NOx). These reductions were all statistically significant improvements. There was no significant difference in either city or highway fuel economy.

The Ford F-150 had a 4% reduction in both non-methane hydrocarbons (NMHC) and carbon monoxide (CO), a 6% reduction in hydrocarbons (HC) and an 18% reduction oxides of nitrogen

(NO_x). The reductions in HC and NO_x were statistically significant improvements; the reductions in NMHC and CO were not statistically significant. There was no change in the city fuel economy, but there was a two percent reduction in highway fuel economy. This change in highway fuel economy was statistically significant.

The results of these test series are found in Tables 1 and 4.

After 1000 Miles with TPC Installed

The Dodge Caravan had an 11% reduction in both hydrocarbons (HC) and non-methane hydrocarbons (NMHC), a 17% reduction in carbon monoxide (CO), and a 37% reduction in oxides of nitrogen (NO_x). These were all statistically significant improvements. There was no significant difference in either city or highway fuel economy.

The Ford F-150 had a 10% reduction in both hydrocarbons (HC) and carbon monoxide (CO), an 8% in non-methane hydrocarbons (NMHC), and a 20% reduction in oxides of nitrogen (NO_x). These were all statistically significant improvements. There was no significant difference in either city or highway fuel economy.

The results of these test series are found in Tables 2 and 5.

After Removal of the TPC - Vehicles Returned to Stock Configuration

The Dodge Caravan had a 1% increase in hydrocarbons (HC), an 11% increase in carbon monoxide (CO), a 2% increase in non-methane hydrocarbons (NMHC), and a 4% reduction in oxides of nitrogen (NO_x). These results were not, however, statistically significant differences. Although there was no significant difference in city fuel economy there was a 2% improvement in highway fuel economy which was significant.

The Ford F-150 had a 2% reduction in hydrocarbons (HC), an 8% reduction in carbon monoxide (CO), and a 19% reduction in oxides of nitrogen (NO_x). There was no change in the non-methane hydrocarbons (NMHC) emissions. These were statistically significant improvements for NO_x and CO but not for HC. There was no significant difference in either city or highway fuel economy.

The results of these test series are found in Tables 3 and 6.

The individual exhaust gas bag data generated for all of the test series for both test vehicles can be found in Tables 7 and 8.

Conclusions

The exhaust emissions reductions were statistically significant using the Tail Pipe Cat on both test vehicles in the initially installed configuration as well as after one thousand miles of driving with the device installed with two exceptions. The carbon monoxide and non-methane

hydrocarbon reductions of four percent on the Ford after initial installation of the Tail Pipe Cat were not statistically significant.

The impact of using the Tail Pipe Cat on the Dodge vehicle (with 80,724 miles at test start) generated greater relative reductions in emissions than those for the Ford (with 17,123 miles at test start). It is suspected that these differences are due to the mileage differences between the two vehicles.

The Ford also maintained a statistically significant reduction in CO and NO_x when returned to stock configuration after removal of the Tail Pipe Cat. It is suspected that the Ford may have “drifted” from the original stock configuration test series since removal of the device should not have had an effect on emissions. This phenomenon did not occur with the Dodge.

Use of the Tail pipe Cat did have a beneficial effect of reducing exhaust emissions. The product was not designed to have an effect on fuel economy, and this was confirmed in this evaluation.

Although this evaluation was confined to light duty trucks to ease installation of the device, it would be reasonable to assume that similar results might be realized with the device installed on light duty vehicles (i.e., passenger cars) provided that the catalyst loading is not reduced for commercially available units.

This evaluation did not include any testing for long term durability of the device itself or the long term durability of the vehicle with the device installed. This would have required extended mileage accumulation which was beyond the scope of this evaluation. Therefore, no conclusions about long term durability can be drawn from this report.

Conclusions and results of this evaluation may not be taken out of context for promotional purposes.

1996 DODGE CARAVAN (with 80,724 miles at test start)

TABLE 1

Initial Installation of Tail Pipe Cat Versus Stock Configuration												
Pollutant/Fuel Economy	Stock Configuration				Tail Pipe Cat Installed (No mileage accumulation)						Percent Difference	Statistically Significant
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Test 4	Test 5	Average		
HC (grams/mile)	0.215	0.195	0.206	0.205	0.181	0.174	0.169	0.161	0.170	0.171	- 17	YES
CO (grams/mile)	1.593	1.499	1.909	1.667	1.255	1.166	1.210	0.980	1.251	1.172	- 30	YES
NOx (grams/mile)	0.549	0.461	0.485	0.498	0.291	0.293	0.295	0.305	0.351	0.307	- 38	YES
NMHC (grams/mile)	0.189	0.171	0.181	0.180	0.159	0.153	0.148	0.140	0.150	0.150	-17	YES
“City” Fuel Economy (mpg)	18.8	19.3	19.4	19.2	19.2	19.5	19.5	19.1	19.2	19.3	1	NO
“Highway” Fuel Economy (mpg)	29.6	29.3	29.2	29.4	29.3	29.2	30.3	29.2	28.6	29.3	0	NO

1996 DODGE CARAVAN (with 80,724 miles at test start)

TABLE 2

After 1000 miles with Tail Pipe Cat Installed Versus Stock Configuration												
Pollutant/Fuel Economy	Stock Configuration				Tail Pipe Cat Installed (After 1000 miles)						Percent Difference	Statistically Significant
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Test 4	Test 5	Average		
HC (grams/mile)	0.215	0.195	0.206	0.205	0.187	0.173	0.183	0.177	0.189	0.182	- 11	YES
CO (grams/mile)	1.593	1.499	1.909	1.667	1.307	1.325	1.484	1.284	1.490	1.378	- 17	YES
NOx (grams/mile)	0.549	0.461	0.485	0.498	0.279	0.331	0.320	0.301	0.327	0.312	- 37	YES
NMHC (grams/mile)	0.189	0.171	0.181	0.180	0.168	0.151	0.161	0.157	0.167	0.161	-11	YES
“City” Fuel Economy (mpg)	18.8	19.3	19.4	19.2	18.8	18.9	19.5	18.9	19.1	19.0	- 1	NO
“Highway” Fuel Economy (mpg)	29.6	29.3	29.2	29.4	29.3	28.9	29.4	28.9	29.7	29.2	0	NO

1996 DODGE CARAVAN (with 80,724 miles at test start)

TABLE 3

Stock Configuration After Removal of Tail Pipe Cat Versus Stock Configuration										
Pollutant/Fuel Economy	Stock Configuration				Returned to Stock Configuration				Percent Difference	Statistically Significant
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Average		
HC (grams/mile)	0.215	0.195	0.206	0.205	0.211	0.206	0.208	0.208	1	NO
CO (grams/mile)	1.593	1.499	1.909	1.667	1.926	1.728	1.885	1.846	11	NO
NOx (grams/mile)	0.549	0.461	0.485	0.498	0.474	0.487	0.469	0.477	- 4	NO
NMHC (grams/mile)	0.189	0.171	0.181	0.180	0.185	0.182	0.183	0.183	2	NO
“City” Fuel Economy (mpg)	18.8	19.3	19.4	19.2	19.3	19.4	19.4	19.4	1	NO
“Highway” Fuel Economy (mpg)	29.6	29.3	29.2	29.4	30.0	29.9	29.6	29.8	2	YES

1996 FORD F-150 (with 17,123 miles at test start)

TABLE 4

Initial Installation of Tail Pipe Cat Versus Stock Configuration													
Pollutant/Fuel Economy	Stock Configuration				Tail Pipe Cat Installed (No mileage accumulation)							Percent Difference	Statistically Significant
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average		
HC (grams/mile)	0.162	0.151	0.154	0.156	0.141	0.155	0.137	0.148	0.141	0.152	0.146	- 6	YES
CO (grams/mile)	1.051	0.941	1.042	1.011	0.916	1.050	0.841	0.983	1.001	1.012	0.967	- 4	NO
NOx (grams/mile)	0.415	0.421	0.407	0.414	0.359	0.346	0.323	0.324	0.349	0.344	0.341	- 18	YES
NMHC (grams/mile)	0.119	0.108	0.114	0.114	0.101	0.115	0.104	0.114	0.107	0.115	0.109	-4	NO
“City” Fuel Economy (mpg)	16.2	16.0	16.1	16.1	16.0	16.1	16.0	16.1	16.2	16.2	16.1	0	NO
“Highway” Fuel Economy (mpg)	23.5	23.3	23.5	23.4	23.1	22.7	23.0	23.2	22.8	23.2	23.0	-2	YES

1996 FORD F-150 (with 17,123 miles at test start)

TABLE 5

After 1000 miles with Tail Pipe Cat Installed Versus Stock Configuration													
Pollutant/Fuel Economy	Stock Configuration				Tail Pipe Cat Installed (After 1000 miles)							Percent Difference	Statistically Significant
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average		
HC (grams/mile)	0.162	0.151	0.154	0.156	0.131	0.130	0.141	0.149	0.141	0.150	0.140	- 10	YES
CO (grams/mile)	1.051	0.949	1.042	1.011	0.873	0.865	0.899	0.965	0.933	0.929	0.911	- 10	YES
NOx (grams/mile)	0.415	0.421	0.407	0.414	0.333	0.298	0.346	0.363	0.301	0.348	0.332	- 20	YES
NMHC (grams/mile)	0.119	0.108	0.114	0.114	0.098	1.050	0.841	0.983	1.001	1.012	0.105	-8	YES
“City” Fuel Economy (mpg)	162	16.0	16.1	16.1	16.1	16.1	16.1	16.2	16.2	16.1	16.1	0	NO
“Highway” Fuel Economy (mpg)	23.5	23.3	23.5	23.4	23.1	23.3	23.4	23.3	23.4	23.7	23.4	0	NO

1996 FORD F-150 (with 17,123 miles at test start)

TABLE 6

Stock Configuration After Removal of Tail Pipe Cat Versus Stock Configuration										
Pollutant/Fuel Economy	Stock Configuration				Returned to Stock Configuration				Percent Difference	Statistically Significant
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Average		
HC (grams/mile)	0.162	0.151	0.154	0.156	0.155	0.143	0.158	0.152	- 2	NO
CO (grams/mile)	1.051	0.949	1.042	1.011	0.925	0.947	0.911	0.928	- 8	YES
NOx (grams/mile)	0.415	0.421	0.407	0.414	0.339	0.330	0.344	0.338	- 19	YES
NMHC (grams/mile)	0.119	0.108	0.114	0.114	0.114	0.107	0.119	.0113	0	NO
“City” Fuel Economy (mpg)	162	16.0	16.1	16.1	16.2	16.2	16.2	16.2	1	NO
“Highway” Fuel Economy (mpg)	23.5	23.3	23.5	23.4	23.5	23.7	23.7	23.6	1	NO

Individual Gas Bag Data for the 1996 Dodge Caravan (with 80,724 miles at test start)

TABLE 7

<u>Test Series</u>	<u>Test Date</u>	<u>Bag 1 HC</u>	<u>Bag 1 NOx</u>	<u>Bag 1 CO</u>	<u>Bag 1 NMHC</u>	<u>Bag 1 FE</u>	<u>Bag 2 HC</u>	<u>Bag 2 NOx</u>	<u>Bag 2 CO</u>	<u>Bag 2 NMHC</u>	<u>Bag 2 FE</u>	<u>Bag 3 HC</u>	<u>Bag 3 NOx</u>	<u>Bag 3 CO</u>	<u>Bag 3 NMHC</u>	<u>Bag 3 FE</u>	<u>FTP HC</u>	<u>FTP NOx</u>	<u>FTP CO</u>	<u>FTP NMHC</u>	<u>FTP FE</u>	<u>HWY HC</u>	<u>HWY NOx</u>	<u>HWY CO</u>	<u>HWY FE</u>
SC 1-1	8/07/98	0.812	1.210	4.869	0.766	18.9	0.041	0.275	0.493	0.024	17.7	0.091	0.566	1.192	0.065	21.1	0.215	0.549	1.593	0.189	18.8	0.024	0.146	0.509	29.6
SC 1-2	8/11/98	0.733	1.145	4.680	0.689	19.0	0.037	0.168	0.417	0.021	18.6	0.087	0.497	1.139	0.062	21.3	0.195	0.461	1.499	0.171	19.3	0.024	0.159	0.612	29.3
SC 1-3	8/12/98	0.791	1.087	6.541	0.744	19.2	0.040	0.245	0.585	0.022	18.6	0.078	0.484	0.907	0.054	21.4	0.206	0.485	1.909	0.181	19.4	0.022	0.160	0.451	29.2
TPC-1	8/14/98	0.746	0.918	5.046	0.703	18.9	0.023	0.064	0.082	0.009	18.5	0.053	0.245	0.597	0.031	21.1	0.181	0.291	1.255	0.159	19.2	0.017	0.023	0.317	29.3
TPC-2	8/18/98	0.716	0.888	4.444	0.676	19.1	0.017	0.058	0.055	0.005	18.8	0.061	0.287	0.784	0.037	21.3	0.174	0.293	1.166	0.153	19.5	0.015	0.026	0.524	29.2
TPC-3	8/19/98	0.701	0.881	4.833	0.659	19.0	0.018	0.075	0.064	0.006	18.8	0.052	0.268	0.638	0.030	21.4	0.169	0.295	1.210	0.148	19.5	0.014	0.022	0.318	30.3
TPC-4	8/25/98	0.654	0.927	3.566	0.615	19.0	0.020	0.064	0.085	0.006	18.3	0.056	0.291	0.716	0.033	20.9	0.161	0.305	0.980	0.140	19.1	0.017	0.031	0.629	29.2
TPC-5	8/27/98	0.695	0.948	4.364	0.658	19.0	0.018	0.079	0.103	0.006	18.4	0.062	0.413	1.067	0.038	21.1	0.170	0.351	1.251	0.150	19.2	0.016	0.036	0.790	28.6
TPCM-1	9/22/98	0.783	0.906	5.094	0.744	18.7	0.014	0.054	0.078	0.004	17.9	0.064	0.229	0.756	0.042	21.0	0.187	0.279	1.307	0.168	18.8	0.017	0.032	0.314	29.3
TPCM-2	9/25/98	0.693	0.961	4.897	0.652	18.7	0.022	0.089	0.152	0.008	18.0	0.063	0.310	0.839	0.040	21.0	0.173	0.331	1.325	0.151	18.9	0.017	0.031	0.410	28.9
TPCM-3	9/29/98	0.729	0.887	5.521	0.687	19.0	0.027	0.098	0.213	0.014	18.7	0.065	0.310	0.839	0.042	21.5	0.183	0.320	1.484	0.161	19.5	0.017	0.031	0.331	29.4
TPCM-4	10/02/98	0.722	0.918	4.862	0.682	18.7	0.020	0.071	0.131	0.008	17.9	0.062	0.270	0.753	0.039	21.3	0.177	0.301	1.284	0.157	18.9	0.016	0.035	0.249	28.9
TPCM-5	10/06/98	0.789	0.909	5.701	0.746	18.9	0.018	0.096	0.196	0.005	18.1	0.058	0.323	0.747	0.036	21.5	0.189	0.327	1.490	0.167	19.1	0.014	0.031	0.225	29.7
SC 2-1	10/14/98	0.803	1.103	5.666	0.759	18.8	0.034	0.193	0.751	0.015	18.5	0.097	0.528	1.312	0.073	21.6	0.211	0.474	1.926	0.185	19.3	0.026	0.147	0.511	30.0
SC 2-2	10/15/98	0.770	1.173	5.304	0.725	19.2	0.043	0.203	0.530	0.027	18.5	0.088	0.503	1.279	0.064	21.6	0.206	0.487	1.728	0.182	19.4	0.022	0.131	0.332	29.9
SC 2-3	10/16/98	0.794	1.079	6.118	0.746	19.2	0.037	0.214	0.546	0.020	18.5	0.089	0.487	1.215	0.065	21.6	0.208	0.469	1.885	0.183	19.4	0.021	0.150	0.451	29.6

HC = Hydrocarbons, grams per mile
 NOx = Oxides of nitrogen, grams per mile
 CO = Carbon monoxide, grams per mile
 FE = Fuel economy, miles per gallon
 FTP= City Drive Test
 HWY = HFET, Highway Test

Test Series:
 SC-1 = Stock configuration before Tail Pipe Cat
 TPC = Tail Pipe Cat installed
 TPCM = Tail Pipe Cat installed;1000 accumulated miles
 SC 2 = Stock configuration after removing TPC

Individual Gas Bag Data for the 1996 Ford F-150 (with 17,123 miles at test start)

TABLE 8

<u>Test Series</u>	<u>Test Date</u>	<u>Bag 1 HC</u>	<u>Bag 1 NOx</u>	<u>Bag 1 CO</u>	<u>Bag 1 NMHC</u>	<u>Bag 1 FE</u>	<u>Bag 2 HC</u>	<u>Bag 2 NOx</u>	<u>Bag 2 CO</u>	<u>Bag 2 NMHC</u>	<u>Bag 2 FE</u>	<u>Bag 3 HC</u>	<u>Bag 3 NOx</u>	<u>Bag 3 CO</u>	<u>Bag 3 NMHC</u>	<u>Bag 3 FE</u>	<u>FTP HC</u>	<u>FTP NOx</u>	<u>FTP CO</u>	<u>FTP NMHC</u>	<u>FTP FE</u>	<u>HWY HC</u>	<u>HWY NOx</u>	<u>HWY CO</u>	<u>HWY FE</u>
SC 1-1	8/26/98	0.480	0.706	4.631	0.421	16.0	0.054	0.249	0.021	0.016	15.4	0.126	0.509	0.286	0.083	17.8	0.162	0.415	1.051	0.119	16.2	0.033	0.359	0.011	23.5
SC 1-2	8/28/98	0.472	0.765	4.332	0.413	15.6	0.051	0.233	0.025	0.015	15.5	0.096	0.514	0.108	0.055	17.5	0.151	0.421	0.941	0.108	16.0	0.031	0.353	0.011	23.3
SC 1-3	9/02/98	0.497	0.782	4.594	0.438	15.9	0.046	0.205	0.025	0.015	15.5	0.098	0.505	0.275	0.057	17.7	0.154	0.407	1.042	0.114	16.1	0.031	0.363	0.011	23.5
TPC-1	9/10/98	0.441	0.708	4.131	0.386	15.6	0.043	0.151	0.025	0.011	15.4	0.100	0.488	0.168	0.057	17.3	0.141	0.359	0.916	0.101	16.0	0.031	0.327	0.014	23.1
TPC-2	9/11/98	0.495	0.641	4.735	0.435	15.7	0.036	0.150	0.034	0.006	15.4	0.124	0.492	0.184	0.079	17.8	0.155	0.346	1.050	0.115	16.1	0.030	0.369	0.012	22.7
TPC-3	9/15/98	0.420	0.658	3.724	0.374	15.6	0.037	0.130	0.021	0.013	15.5	0.111	0.434	0.213	0.072	17.5	0.137	0.323	0.841	0.104	16.0	0.027	0.311	0.012	23.0
TPC-4	9/16/98	0.452	0.648	4.416	0.401	15.6	0.036	0.144	0.026	0.011	15.5	0.132	0.417	0.195	0.091	17.6	0.148	0.324	0.983	0.114	16.1	0.029	0.303	0.010	23.2
TPC-5	9/17/98	0.453	0.643	4.533	0.401	15.7	0.034	0.158	0.021	0.011	15.7	0.107	0.485	0.187	0.068	17.6	0.141	0.349	1.001	0.107	16.2	0.026	0.313	0.009	22.8
TPC-6	9/18/98	0.470	0.668	4.447	0.412	15.7	0.037	0.151	0.022	0.011	15.6	0.128	0.463	0.280	0.087	17.7	0.152	0.344	1.012	0.115	16.2	0.026	0.314	0.011	23.2
TPCM-1	10/22/98	0.431	0.670	3.823	0.381	15.6	0.033	0.128	0.021	0.011	15.5	0.090	0.462	0.251	0.050	17.7	0.131	0.333	0.873	0.098	16.1	0.028	0.268	0.010	23.1
TPCM-2	10/23/98	0.431	0.583	3.747	0.383	15.6	0.031	0.140	0.026	0.008	15.6	0.088	0.382	0.275	0.047	17.8	0.130	0.298	0.865	0.097	16.1	0.028	0.254	0.008	23.3
TPCM-3	10/29/98	0.456	0.667	4.007	0.401	15.5	0.041	0.167	0.027	0.013	15.5	0.092	0.442	0.197	0.053	17.7	0.141	0.346	0.899	0.105	16.1	0.030	0.267	0.011	23.4
TPCM-4	10/30/98	0.460	0.623	4.356	0.407	15.6	0.042	0.195	0.027	0.015	15.7	0.117	0.487	0.192	0.076	17.7	0.149	0.363	0.965	0.113	16.2	0.031	0.291	0.010	23.3
TPCM-5	11/05/98	0.441	0.619	4.125	0.391	15.6	0.036	0.116	0.034	0.012	15.7	0.113	0.411	0.218	0.073	17.9	0.141	0.301	0.933	0.108	16.2	0.031	0.278	0.011	23.4
TPCM-6	11/20/98	0.447	0.669	4.171	0.391	15.7	0.050	0.163	0.009	0.014	15.5	0.116	0.453	0.218	0.073	17.9	0.150	0.348	0.929	0.109	16.1	0.039	0.300	0.001	23.7
SC 2-1	12/02/98	0.476	0.652	4.131	0.420	15.9	0.049	0.173	0.010	0.070	15.5	0.111	0.415	0.228	0.070	18.0	0.155	0.339	0.925	0.114	16.2	0.033	0.275	0.001	23.5
SC 2-2	12/03/98	0.451	0.667	4.183	0.399	15.8	0.043	0.132	0.006	0.059	15.5	0.098	0.446	0.276	0.059	18.0	0.143	0.330	0.947	0.107	16.2	0.031	0.287	0.002	23.7
SC 2-3	12/08/98	0.482	0.660	4.014	0.429	15.8	0.044	0.169	0.010	0.084	15.5	0.128	0.435	0.264	0.084	18.0	0.158	0.344	0.911	0.119	16.2	0.032	0.335	0.001	23.7

HC = Hydrocarbons, grams per mile
 NOx = Oxides of nitrogen, grams per mile
 CO = Carbon monoxide, grams per mile
 FE = Fuel economy, miles per gallon
 FTP= City Drive Test
 HWY= HFET, Highway Test

Test Series:
 SC 1 = Stock configuration before installing TPC
 TPC = Tail Pipe Cat installed
 TPCM = Tail Pipe Cat installed; 1000 accumulated miles
 SC 2 = Stock configuration after removing TPC

APPENDIX

The following appendix documents are only available with the hard copy version of this report copies of which may be purchased from National Technical Information Services (NTIS). Prices and order information may be obtained by calling: 800-553-6847.

1. Tail Pipe Cat Application for Evaluation

2. Independent Test Lab Test Reports

- a. 1991 GMC Jimmy
- b. 1991 Jeep Cherokee
- c. 1994 Jeep Wagoneer
- d. 1995 Dodge Intrepid

3. Test Plan Agreement