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EFFECT OF EVAPORATIVE CANISTER REMOVAL AND REID VAPOR PRESSURE ON HYDROCARBON EVAPORATIVE EMISSIONS

by

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I. INTRODUCTION:

At the request of the Technical Support Staff of EPA's Emission Control Technology Division, the Technology Evaluation Branch tested six vehicles for evaporative emissions with their evaporative canisters removed. Two of these six were also tested with their canisters installed. The other four vehicles were tested with their canisters installed in a prior project, but those data are also included in this report.

For this test effort the vehicles were tested with two fuels; Indolene HO, which is an unleaded gasoline that meets EPA test fuel specifications, and an unleaded commercial gasoline. Commercial fuel specifications generally allow greater variance in batch to batch characteristics than Indolene. Also, among other differences, the volatility of commercial gasoline can be significantly higher than Indolene's volatility. Refiners routinely adjust commercial fuels' volatility to accommodate ambient pressures and temperatures that vary with geographic location and seasonal changes within geographic regions.

The Environmental Protection Agency (EPA) uses air quality models to predict the impact of atmospheric pollutants on the Nation's air quality. A prerequisite to accurate air quality predictions is data on the emission levels of current and future pollutant sources. MOBILE3 is the name of the newest model used to predict these emission rates for on-road vehicles. In-use data collected through EPA's National Emission Factors programs have shown that in some cases it is incorrect to assume that the emission rates of on-road pollutant sources are at or below the standards they were designed to comply with. MOBILE3 is therefore designed to permit employing in-use data to reflect real-world conditions. The emission rates predicted by MOBILE3 are then utilized by the air quality models.

The 1977 amendments to the Clean Air Act, Sections 203(a)(3)(A) and (B), make it illegal for automobile dealers, fleet operators, and repair or service facilities, to disconnect or modify emission control systems. However, surveys conducted in 1978, 1979, 1981 and 1982 found that evaporative control system tampering occurrences ranged from 1.5% in the 1982 survey to 2.6% in the 1978 survey [1]. Thus, the emission rates predicted by MOBILE3, and the subsequent air quality predictions will be in error if not corrected for this tampering. Since over one-half of the hydrocarbons in urbanized areas are from automobile emissions [1], evaporative control system tampering can significantly affect air quality and should be accounted for.

This test program was designed to quantify the evaporative emissions increase on in-use vehicles that have had their evaporative canisters disconnected. The data are to be used in EPA's MOBILE3 emission rates model.

Surveys have also found that the Reid Vapor Pressures (RVP) of commercial gasolines in some geographical regions are higher than Indolene HO's RVP [2]. Emission factors data indicate that evaporative emissions increase as RVP increases [3]. Since the emission rates have been based on vehicles tested with Indolene, the data must be corrected to reflect the real-world situation wherein vehicles use gasolines with higher RVPs than Indolene.

So in addition to quantifying the evaporative emissions increase with disconnected canisters, this project is also a follow-up to an EPA project that assessed the effect of RVP on evaporative emissions and resulted in a report entitled "Effects of Reid Vapor Pressure on Hydrocarbon Evaporative Emissions" (see Reference 3).

An additional follow-on project evaluated the effect of RVP on evaporative emissions of older vehicles whose model years ranged from 1963 to 1975. A final report on the older vehicles project is in preparation and will be released in the near future.

This report on evaporative canister removal (tampering) will:

1. Quantify the increase in evaporative emissions when evaporative canisters are removed from in-use vehicles.

2. Quantify the increase in evaporative emissions when the Indolene HO test fuel (RVP=9.1 psi) is replaced by a commercial fuel with a Reid Vapor Pressure of 11.7 psi. This discussion will be limited to the change in emissions when the canisters are removed. RVP effects with the canisters installed are discussed in Reference 3.

The data will be used in the MOBILE3 on-road vehicle emission rates model to improve the accuracy of its predictions and in-turn improve the accuracy of EPA's air quality predictions.

II. TEST VEHICLES

The following table lists the six vehicles that were tested. The table also includes the evaporative HC emission standard and the test procedure they were certified under.

	Emission Standard g/test	Certification Test Procedure
1974 Buick Century	2*	carbon trap method
1975 Chevy Nova	2*	carbon trap method
1979 Ford Pinto	6.0	SHED
1979 Olds Cutlass	6.0	SHED
1983 Olds Custom Cruiser (Wagon)	2.0*	SHED
1983 Plymouth Reliant	2.0*	SHED

Vehicle descriptions are provided in Appendix B. The two 1983 vehicles were set to manufacturers' specifications before testing. The other four vehicles were checked out, but were not set to manufacturer's specifications unless EPA judged that the problem would have been apparent to the typical owner. The checklists for these four vehicles are in Appendix C.

The 6.0 g/test standard of the two 1979 vehicles is numerically less stringent than 2 g/test standard of the 1974 and 1975 vehicles. However, the certification test procedure was changed from the carbon trap method to the Sealed Housing for Evaporative Determination (SHED) method for the 1978 model year vehicles. This test procedure change effectively made the 6.0 g/test standard more stringent than the 2 g/test standard.

A significant evaporative control system difference between the 2 g/test vehicles and the other four vehicles is the method of carburetor float bowl venting. The 2 g/test vehicles have their float bowls vented through the air cleaners. The float bowls are vented through the carbon canisters of the other four vehicles.

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* Note the difference in significant digits between the 2 g/test standard and the 2.0 g/test standard. Subsequent discussions refer to the vehicles by the standards they are certified under and could cause confusion if the reader incorrectly assumes they are the same standard. The test procedures are also different.

III. TEST PLAN

The basic Federal Test Procedure (FTP) with the SHED procedure was used for exhaust and evaporative emission testing of the six vehicles. Although exhaust emission tests were run and the results are available, they will not be discussed in this document.

The FTP requires that the vehicles be preconditioned with the Urban Dynamometer Driving Schedule (UDDS) which is more commonly referred to as the LA-4 driving cycle. The LA-4 was used to precondition four of the vehicles with their canisters installed. These vehicles were previously tested to support the project documented in Reference 3. They are the 1979 Ford Pinto, 1979 Olds Cutlass, 1983 Olds Wagon, and the 1983 Plymouth Reliant. The LA-4 duration is 1372 seconds (22.9 minutes) and nominally 7.45 miles.

All six vehicles listed in Section II of this report were tested with their canisters removed to support the project documented in this report. They were not preconditioned with the LA-4. The LA-4 cycle was abbreviated to its first 630 seconds (4.04 miles) and is referred to as Cycle B. All six vehicles were preconditioned with Cycle B in the "canister-removed" configuration. Cycle B was also used for the 1974 Buick Century and the 1975 Chevy Nova with their canisters installed, as well as with their canisters removed.

With their canisters installed, each vehicle was tested a minimum of four times; two tests with Indolene HO and two tests with unleaded commercial fuel. The test sequences are listed in Appendix A. Because of high variability, the Ford Pinto received 3 tests with Indolene and the 1979 Olds Cutlass received 3 tests with commercial fuel.

The canisters were then removed from the vehicles to minimize the test variability which might occur with an incompletely purged canister still in the car. The hoses to the canister were left open. Each car received two tests with its canister removed, one with Indolene HO and one with commercial unleaded gasoline.

IV. TEST RESULTS

1. Effect of Canister Removal on Emissions

a. General Results

Table 1 lists the evaporative test result averages for each vehicle. The individual test results are presented in Appendix D. Table 2 summarizes the mean change in emissions after the canisters were removed, and lists the coefficients of variation (COV). Table 3 stratifies the vehicles into three categories based on the emission standard and test procedure they were certified under. It lists the average evaporative emissions for each category with the canisters removed. MOBILE3 uses discrete inputs for diurnal and hot soak emissions rather than total evaporative emissions, so Tables 2, 3 and 4, and the following discussion do not include total emissions.

Canister removal caused larger increases in commercial fuel diurnal and hot soak emissions than for Indolene emissions. Diurnal emissions (Table 2) increased an average of 15.24 g/test with Indolene and 21.73 g/test with commercial fuel. Hot soak emissions respectively increased 8.26 and 9.81 g/test when the canisters were removed. Note that this discussion concerns the average change in emissions rather than the total mass, which was also higher with commercial fuel. The high COVs (27% to 74%) in Table 2 indicate that evaporative emission sensitivity to canister disablement varies widely from vehicle to vehicle.

Diurnal emissions increased more with commercial fuel than with Indolene on all six vehicles (Table 1). Hot soak emissions also increased more with commercial fuel than with Indolene, on four of the six vehicles. The 1974 Buick Century and the 1975 Chevrolet Nova had larger increases in hot soak emissions with Indolene. Their increases were 5.18 g/test for the Buick and 9.95 g/test for the Nova. These hot soak Indolene increases were in-line with the other four vehicles whose increases ranged between 4.67 g/test for the 1983 Olds Wagon and 10.82 g/test for the 1979 Olds Cutlass. The Buick actually showed an insignificant decrease in commercial fuel hot soak emissions (0.05 g/test) when the canister was removed and the Nova increased only 3.33 grams. The other four vehicles had an average increase in hot soak emissions of 13.89 g/test with commercial fuel.

b. Buick and Nova Hot Soak Results

The small changes in commercial fuel hot soak emissions as a result of canister disablement on the Buick and the Nova appear questionable. In comparison, the other four vehicles' hot soak emissions increased significantly. However, the Buick and Nova commercial fuel emission changes appear logical when the evaporative control systems of the vehicles are considered. The Buick and Nova are the only vehicles whose carburetor float bowls are not vented through their canisters. Therefore, removing their canisters should not affect the evaporative emissions from their carburetors.

The Exxon Research and Engineering Company found that

> "Hydrocarbon vapors escaping from the air cleaner during the hot soak are by far the largest contributor to evaporative losses. One half of the hydrocarbon loss is by this route with vapors escaping from the air cleaner snorkel." [4]

This finding was based on SHED testing of twenty 1973 to 1975 vehicles. Thus, the small increase in hot soak emissions that occurred after canister removal is not surprising since most of the float bowl hydrocarbons escape from the air cleaner. The other four vehicles' float bowls are vented through their canisters, so removing their canisters can be expected to result in a significant increase in evaporative HC emissions.

While these factors may explain why commercial fuel hot soak emissions did not increase on the Buick and Nova, they throw the Indolene hot soak emissions into question. Why did Indolene hot soak emissions increase with canister removal if their canisters are not used to control float bowl emissions? The Exxon report stated that the second and third largest evaporative emission contributors were respectively carburetor leaks and canister overflow. Carburetor leaks should not be pertinent since the same carburetors were used with both fuels, but canister overflow may provide the solution to the riddle.

The Exxon report said that overflow from the canister

> "is the third largest source of evaporative emissions with 10% occurring during the diurnal cycle and an additional 10% during the hot soak. This indicates insufficient working capacity in the canister of five of the twenty cars in the group." [4]

The Exxon vehicles were tested with Indolene HO which has an RVP specification that holds the RVP range to between 8.7 and 9.2 psi. The commercial fuel used in this project had an RVP of 11.7 psi. The high volatility of this fuel may have led to canister overloading during the diurnal test.

How would canister overloading provide an explanation for the increase in hot soak Indolene emissions with no change in hot soak commercial fuel emissions? The explanation relies on four assumptions. First assume that the Indolene diurnal tests did not overload the canisters, but they were overloaded on the commercial fuel diurnal tests. Or, assume that the FTP driving cycle previous to the Indolene hot soak test sufficiently purged the canisters, but did not sufficiently purge the canisters when commercial fuel was used. Second, assume that evaporative emissions escaped from the fuel tank vent hoses during the hot soak test. The vent hoses were left open when the canisters were removed. Third, assume that the installed canisters were overloaded (first assumption) during the commercial fuel diurnal tests. Therefore, they would have been ineffective in controlling fuel tank emissions during the hot soak test. Fourth, assume that the canisters were not overloaded during the Indolene diurnal tests. Therefore, they would have been effective in controlling fuel tank emissions during the hot soak test.

If these assumptions are correct, removing the canister should have caused an increase in Indolene hot soak emissions since an effective control device was removed. Conversely, commercial fuel hot soak emissions should not have increased when the canister was removed since it was ineffective before it was removed. This explanation is offered as a theory; it has not been experimentally verified.

Although the commercial fuel hot soak emissions for the Buick and Nova hardly changed after the canisters were removed, their mass emissions were roughly two times greater than the emissions of the other vehicles with their canisters removed. This fact bolsters the theory that the canisters were overloaded during the commercial fuel diurnal test. This also suggests that parameters other than the canisters are responsible for the lower emissions of the four newer vehicles. One difference is the carburetor bowl volumes which range between 45 and 65 cubic centimeters (cc) on the newer vehicles compared to 76 cc on both the Buick and the Nova.

c. Vehicle to Vehicle Variations

As previously stated, the COVs in Table 2 show that the effect of canister disablement varied significantly from vehicle to vehicle. Table 1 shows the range of increase in diurnal emissions was 9.84 g/test for the 1983 Reliant to 19.44 g/test for the 1979 Cutlass with Indolene. The range of increase in diurnal emissions with commercial fuel was 14.80 g/test for the 1979 Pinto to 28.37 g/test for the 1979 Cutlass. Canister removal allowed hot soak emissions with Indolene to increase from 4.67 g/test for the Olds Wagon to 10.82 g/test on the 1979 Cutlass. Hot soak emissions with commercial gasoline increased from no significant change on the 1974 Buick to 19.04 g/test on the 1983 Reliant. These ranges represent vehicle averages rather than single test extremes.

d. Comparative Results of Vehicles Certified Under Different Evaporative Emission Standards

The data in Table 3 list the average emissions for three vehicle categories - the three evaporative emission standards the vehicles were certified under. The data indicate that the average emissions for vehicles certified under the 2 g/test standard, on average, had higher evaporative emissions than their four counterparts that were certified under more stringent standards.

Comparing the vehicles certified to the 2.0 g/test standard with the vehicles certified to the 6.0 g/test standard show that there is less than a 1.0 g/test difference in the average diurnal emissions of each group. The 2.0 g/test vehicles had lower average hot soak emissions on the tests run with Indolene, but their hot soak emissions were higher than the 6.0 g/test vehicles on the tests run with commercial fuel.

In summary, the "canister-removed" data conclusively show that the vehicles certified under the 2 g/test standard have significantly higher emissions than the other vehicles. But there are not significant group differences between the vehicles certified to the 6.0 g/test standard and vehicles certified to the 2.0 g/test standard.

2. Effect of Fuel Volatility on Evaporative Emissions

This section discusses the change in evaporative emissions when Indolene HO with an RVP of 9.1 pounds per square inch (psi) was replaced with commercial fuel having an RVP of 11.7 psi. This discussion will be limited to the effect of fuel volatility on evaporative emissions with the canister removed since Reference 3 discusses the canister installed configuration.

Table 1 lists the ratios for Indolene fuel evaporative emissions versus commercial fuel emissions. Commercial fuel evaporative emissions with the canisters removed were greater than Indolene emissions in all cases.

The diurnal ratio is defined as the diurnal evaporative emissions with commercial fuel divided by the diurnal emissions with Indolene. The hot soak ratio is calculated in the same manner. Table 4 lists the mean diurnal and hot soak ratios. The six vehicle mean diurnal ratio is 1.7 (Table 4) and the mean hot soak ratio is 1.6. However, the hot soak ratios segregate into two groups. The first group, which includes the 1979 Pinto and the 1979 Cutlass, had a mean hot soak ratio of 1.3. The second, which includes the 1974 Buick, 1975 Nova, 1983 Olds Wagon and the 1983 Plymouth Reliant, had a mean hot soak ratio of 1.8. The mean diurnal ratio is 1.6 for the first group and 1.7 for the second group, but they do not obviously separate into two distinct groups as the hot soak ratios do.

V. SUMMARY OF RESULTS

1. Canister removal caused larger increases in commercial fuel evaporative emissions than for Indolene emissions. Removal caused an average increase in diurnal emissions of 15.2 g/test with Indolene for the six vehicles. On commercial fuel, the mean increase was 21.7 g/test. Mean hot soak emissions increased 8.3 g/test on Indolene and 9.8 g/test on commercial gasoline.

2. The range of increase in diurnal emissions was 9.8 g/test for the 1983 Reliant to 19.4 g/test for the 1979 Cutlass with Indolene. The range of increase in diurnal emissions with commercial fuel was 14.8 g/test for the 1979 Pinto to 28.4 g/test for the 1979 Cutlass. Canister removal allowed hot soak emissions with Indolene to increase from 4.7 g/test for the 1983 Olds Wagon to 10.8 g/test on the 1979 Cutlass. Hot soak emissions with commercial gasoline increased from no change on the 1974 Buick to 19.0 g/test on the 1983 Reliant. These ranges are for vehicle averages rather than single test extremes.

3. The increases in evaporative emissions upon removal of the canisters varied widely from vehicle to vehicle.

4. Canister removal did not make a significant difference in the hot soak emissions of the 1974 Buick and the 1975 Nova when fueled with commercial gasoline.

5. With their canisters removed, the 1974 Buick Century and the 1975 Chevy Nova, which were certified to the 2 g/test standard, had higher diurnal and hot soak emissions (two vehicle averages) on Indolene and commercial fuels than the group average emissions of the other four vehicles which were certified to the more stringent 6.0 g/test* and 2.0 g/test standards.

6. The average diurnal ratio** was 1.7 for the six vehicles.

7. The average hot soak ratio** for the six vehicles was 1.6. However, the hot soak ratios segregate into two groups. The first group, which includes the 1979 Pinto and the 1979 Cutlass, had a mean hot soak ratio of 1.3. The second, which includes the 1974 Buick, 1975 Nova, 1983 Olds Wagon and the 1983 Plymouth Reliant, had a mean hot soak ratio of 1.8.

8. The average diurnal ratio is 1.6 for the first group and 1.7 for the second group; they do not obviously segregate into two distinct groups as do the hot soak ratios.

* Although 6.0 g/test is numerically less stringent than 2 g/test, the test procedure change from the Carbon Trap method to the SHED method resulted the 6.0 g/test standard being a more stringent than the 2 g/test standard.

** The ratio is calculated by dividing commercial fuel emissions by Indolene emissions for tests performed with the canisters removed.

References

1. "Motor Vehicle Tampering Survey - 1982," United States Environmental Protection Agency, Office of Enforcement and Legal Counsel, EPA-330/1-81-001.

2. Analysis of MVMA National Fuel Volatility Data, Memo from Craig A. Harvey, Technical Support Staff to Charles L. Gray, Jr., Emission Control Technology Division, October 7, 1983.

3. "Effects of Reid Vapor Pressure on Hydrocarbon Evaporative Emissions," Edward Anthony Barth, Environmental Protection Agency, EPA-AA-TEB-84-3.

4. Investigation and Assessment of Light-Duty Vehicle Evaporative Emission Sources and Control - Contract #68 - 03 - 2172, U.S. EPA - Exxon Research and Engineering Company, P.J. Clarke, October 1975.

Table 1

Mean Evaporative Emissions with Indolene and Commercial Fuels

Vehicle	Canister	Diurnal Ind. HC (g/test)	Diurnal Comm.	Diurnal Ratio*	Hot Soak Ind. HC (g/test)	Hot Soak Comm.	Hot Soak Ratio*	Total Ind. HC (g/test)	Total Comm.	Total Ratio*	Number of Tests Ind.	Number of Tests Comm.
1974 Buick Century**	Installed	5.50	17.24	3.1	10.74	27.37	2.5	16.25	44.61	2.7	2	2
1974 Buick Century**	Removed	22.46	36.59	1.6	15.92	27.32	1.7	38.38	63.91	1.7	1	1
Change		16.96	19.35		5.18	-0.05		22.13	19.30			
1975 Chevy Nova**	Installed	2.58	10.20	4.0	10.00	31.53	3.2	12.59	41.73	3.3	2	2
1975 Chevy Nova**	Removed	19.33	34.31	1.8	19.95	34.86	1.7	39.29	69.17	1.8	1	1
Change		16.75	24.11		9.95	3.33		26.70	27.44			
1979 Ford Pinto***	Installed	0.23	0.36	1.6	0.68	0.92	1.4	0.91	1.28	1.4	3	2
1979 Ford Pinto**	Removed	10.25	15.16	1.5	9.73	12.18	1.3	19.98	27.34	1.4	1	1
Change		10.02	14.80		9.05	11.26		19.07	26.06			
1979 Olds Cutlass***	Installed	1.89	7.16	3.8	1.78	1.66	0.9	3.67	8.83	2.4	2	3
1979 Olds Cutlass**	Removed	21.33	35.53	1.7	12.60	17.48	1.4	33.93	53.01	1.6	1	1
Change		19.44	28.37		10.82	15.82		30.26	44.18			
1983 Olds Wagon***	Installed	0.72	4.99	6.9	2.74	4.34	1.6	3.46	9.33	2.7	2	2
1983 Olds Wagon**	Removed	19.12	32.98	1.7	7.41	13.79	1.9	26.54	46.76	1.8	1	1
Change		18.40	27.99		4.67	9.45		23.08	37.43			
1983 Plymouth Reliant***	Installed	1.13	2.76	2.4	1.34	1.62	1.2	2.46	4.38	1.78	2	2
1983 Plymouth Reliant**	Removed	10.97	18.52	1.7	11.22	20.66	1.8	22.19	39.18	1.8	1	1
Change		9.84	15.76		9.88	19.04		19.73	34.80			
Mean Change		15.24	21.73		8.26	9.81		23.50	31.54			

* Ratio = Commercial Fuel Emissions/Indolene Emissions.

** Cycle B prep used with both fuels (Cycle B is the first 630 seconds, 4.04 miles, of the LA-4 driving schedule).

*** LA-4 prep cycle used with both fuels.

Table 2

Mean Increase In Emissions Upon Canister Removal for Six Vehicles

Fuel	Increase in Diurnal Emissions	Coefficient of Variation
Indolene HO	15.24 g/test	28%
Commercial	21.73 g/test	27%

Fuel	Change in Hot Soak HC Emissions	Coefficient of Variation
Indolene HO	8.26 g/test	32%
Commercial	9.81 g/test	74%

Table 3

Average Evaporative Emissions of Vehicles Categorized by their Evaporative Emission Standard (Canisters Removed)

Evaporative Standard	Mean Diurnal Emissions		Mean Hot Soak Emissions	
	g/test			
	Indolene	Commercial	Indolene	Commercial
2 g/test*	20.90	35.45	17.94	31.09
6.0 g/test**	15.79	25.34	11.16	14.83
2.0 g/test***	15.04	25.75	9.32	17.22

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* 1974 Buick Century, 1975 Chevy Nova

** 1979 Ford Pinto, 1979 Olds Cutlass

*** 1983 Olds Wagon, 1983 Plymouth Reliant

Table 4

Ratios of Evaporative Emissions (Commercial/Indolene Fuel, Canisters Removed)

Vehicles	Diurnal Ratio Mean	Diurnal Ratio COV	Hot Soak Ratio Mean	Hot Soak Ratio COV	Number of Tests Ind.	Number of Tests Comm.
All six	1.7	6%	1.6	16%	6	6
First Group: '79 Pinto & '79 Cutlass	1.6	9%	1.3	8%	2	2
Second Group: '74 Buick, '75 Nova, '83 Olds, & '83 Reliant	1.7	4%	1.8	4%	4	4

Appendix A-1

Test Sequence With Canisters Installed

Test vehicles for this test sequence are: 1979 Ford Pinto, 1979 Oldsmobile Cutlass, 1983 Oldsmobile Custom Cruiser, and 1983 Plymouth Reliant.

1. Check vehicle.

2. Drain and refuel with Indolene.

3. Road preconditioning - #1 Adrian Road Route (a 125 mile road route).

The standard evaporative emission test consists of Steps 4 through 10 below:

4. Drain and 40% refuel with chilled Indolene.

5. Dynamometer prep using LA-4 driving schedule.
6. Standard soak from 12 hours to 36 hours.

7. Drain and 40% refuel with chilled Indolene.

8. Diurnal evaporative emissions test (one hour soak in SHED enclosure, fuel is heated from 60°F to 84°F).

9. Test using FTP (LA-4 driving schedule with repeat of first 505 seconds).

10. Hot soak evaporative emissions test (one hour soak in SHED enclosure).

11. Repeat numbers 4 through 10 above.

12. Repeat numbers 2 through 10 above using commercial fuel so that each vehicle receives two tests with commercial fuel.

NOTE: All tests were with Indolene HO for the first two tests and commercial unleaded for the next two. The Pinto's first three tests were with Indolene and the 1979 Olds Cutlass's last three tests were with commercial fuel.

Appendix A-2

Test Sequence With Canisters Installed

Test vehicles for this test sequence are: 1974 Buick Century, 1975 Chevrolet Nova.

1. Check vehicle.

2. Drain and refuel with Indolene.

3. Driveability check - one LA-4 driving schedule.

The standard evaporative emission test consists of Steps 4 through 10 below except that the standard LA-4 was replaced by Cycle B in Step 5:

4. Drain and 40% refuel with chilled Indolene.

5. Dynamometer prep using Cycle B driving schedule.

6. Standard soak from 12 hours to 36 hours.

7. Drain and 40% refuel with chilled Indolene.

8. Diurnal evaporative emissions test (one hour soak in SHED enclosure, fuel is heated from 60°F to 84°F).

9. Test using FTP (LA-4 driving schedule with repeat of first 505 seconds).

10. Hot soak evaporative emissions test (one hour soak in SHED enclosure).

11. Repeat numbers 4 through 10 above until each vehicle has completed two tests with Indolene.

12. Repeat numbers 4 through 10 above using commercial fuel so that each vehicle receives two tests with commercial fuel.

NOTES: 1. All tests were with Indolene HO for the first two tests and commercial unleaded for the next two.

2. Cycle B is the first 630 seconds, 4.04 miles, of the LA-4 driving schedule.

Appendix A-3

Test Sequence With Canisters Removed

Test vehicles for this test sequence are: 1974 Buick Century, 1975 Chevrolet Nova, 1979 Ford Pinto, 1979 Oldsmobile Cutlass, 1983 Oldsmobile Custom Cruiser, and 1983 Plymouth Reliant.

1. Remove canisters and leave hoses open

2. Check vehicle and 40% refuel with Indolene.

3. Dynamometer prep using Cycle B driving schedule.

4. Standard soak from 12 hours to 36 hours.

5. Drain and 40% refuel with chilled Indolene.

6. Diurnal evaporative emissions test (one hour soak in SHED enclosure, fuel is heated from 60°F to 84°F).

7. Test using FTP (LA-4 driving schedule with repeat of first half of schedule).

8. Hot soak evaporative emissions test (one hour soak in SHED enclosure).

9. Repeat numbers 2 through 8 above using commercial fuel.

NOTE: Cycle B is the first 630 seconds, 4.04 miles, of the LA-4 driving schedule.

Appendix B-1
Test Vehicle Description
6.0 Gram Evaporative Standard Vehicles

Make/Model	Buick/Century	Chevrolet/Nova	Ford Pinto	Olds Cutlass Supreme
Model Year	1974	1975	1979	1979
Type	Sedan	Sedan	2 dr hatchback	2 dr hardtop
Vehicle ID	4D29H4H156612	1X27L115735	9T11Y186165	3R47A9M523280
Initial OD	59,568	7,645	26,750	37,700 miles
Engine:				
Type	Spark Ignition	Spark Ignition	Spark Ignition	Spark Ignition
Config.	V-8	V-8	In-line 4	V-6
Disp.	350 CID	350 CID	2.3 liters	231 CID
Fuel Metering	2V Carb	2V Carb	2V Carb	2V Carb
Engine Fam.	unknown	11K43	2.3A1X92EGR/CAT	3.8L940B2
Evap. Fam.	unknown	unknown	B	B
Emission Cont. System	AIR/EGR	AIR/OC/EGR	PAIR/OC/EGR	PAIR/OC/EGR
Volumes:				
Fuel Tank	22 gal	21 gal	13 gal	18.2 gal
Carb Bowl	76 cc	76 cc	45 cc	50 cc
Transmission	Automatic 3 Speed	Automatic 3 speed	Automatic 3 speed	Automatic 3 speed
Test Parameters:				
Inertia Wt.	4500 lbs	4000 lbs	2750 lbs	3500 lbs
HP @ 50 MPH	14.0	12.0	9.7	9.5

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Appendix B-2
Test Vehicle Descriptions for
2.0 Gram Evaporative Standard Vehicles

Make/Model	Olds Custom Cruiser	Plymouth Reliant
Model Year	1983	1983
Type	Station Wagon	Sedan
Vehicle ID	1G3AP35Y5DX34364	1P3BP26C9DF251538
Initial OD	22,400 miles	2,500 miles
Engine:		
Type	Spark Ignition	Spark Ignition
Config.	V-8	Transverse 4
Disp.	5.0 Liters	2.2 Liters
Fuel Metering	4V Carb	2V Carb
Engine Fam.	D3G5.0V4ARA9	DCR2.2VHAC3
Evap. Fam.	3B4-3A	DCRKA
Emission Cont. System	AIR/CL-3W/OC/EGR	AIR/CL-3W/OC/EGR
Volumes:		
Fuel Tank	22 gal	13 gal
Carb Bowl	65 cc	51 cc
Transmission	Automatic 4-speed lock-up	Automatic 3 speed
Test Parameters:		
Inertia Wt.	4750 lbs.	2750 lbs.
HP @ 50 MPH	12.7	8.0

VEHICLE CHECKLIST

APPENDIX C-1

Vehicle Mfr.: Buick Year: '74 Model: Century Color: Wine VIN: 4D29H4H156612

Technician/Mechanic: 35694 Date: 1-25-84

1. Install fuel drain		done X	
2. Thermocouple fuel cap for mid-volume fuel temp. when 40% filled		done X	
3. Pressure check fuel system	start 15'	In.H_2O after 5min. 14'	
4. Change engine oil and filter	done X	not necessary	
5. Check differential fluid	ok X	topped off	
6 Check power steering fluid	ok X	topped off	
7. Check transmission fluid	ok	topped off X	
8. Check brake fluid	ok	topped off X	
9. Exhaust system	no leaks X	leaks	
10. Install boot on tailpipe		done X	
11. Canister and hoses visual check	ok X	problem	
12. Brake test	ok X	needs repair	

Ignition System

13. Points: a) dwell		spec 30°	actual 29.3°
b) resistance		ok X	bad
c) timing	spec 4° B	@rpm 650	actual 4.3° @rpm 629
d) advance		functions X	no good
14. Plugs, Wires and Cap- Scope Check		ok X	problem
15. Battery		ok X	problem

Fuel System

16. Choke setting	spec. -	actual -
17. Choke operation	ok X	problem
18. Vacuum break setting	spec. -	actual
19. Vacuum break operation	ok X	problem
20 Air cleaner	ok X	changed
21. Adjust idle mixture to specs.		done
22. Idle speed	spec. 650	actual 631
23. Fast idle speed	spec. -	actual 1970

Miscellaneous

24. Manifold heat valve	ok N/A	problem
25. PCV System	ok X	problem
26. EGR Valve	ok X	problem

VEHICLE CHECKLIST APPENDIX C-2

Vehicle Mfr.: Chevy Year: '75 Model: Nova Color: Yellow VIN: 1X27L5L115735

Technician/Mechanic: 35694 Date: 1-11-84

1. Install fuel drain		done X	
2. Thermocouple fuel cap for mid-volume fuel temp. when 40% filled		done X	
3. Pressure check fuel system	start 15'	In. H_2O after 5min. 14 1/2 '	
4. Change engine oil and filter	done X	not necessary	
5. Check differential fluid	ok X	topped off	
6 Check power steering fluid	ok X	topped off	
7. Check transmission fluid	ok X	topped off	
8. Check brake fluid	ok	topped off X	
9. Exhaust system	no leaks X	leaks	
10. Install boot on tailpipe		done X	
11. Canister and hoses visual check	ok X	problem	
12. Brake test	ok X	needs repair	

Ignition System

13. Points: a) dwell		spec fixed	actual 29.3°
b) resistance		ok X	bad
c) timing	spec 6°B	@rpm 600	actual 8° @rpm 635
d) advance		functions X	no good
14. Plugs, Wires and Cap- Scope Check		ok X	problem
15. Battery		ok X	problem

Fuel System

16. Choke setting	spec. -	actual -
17. Choke operation	ok X	problem
18. Vacuum break setting	spec. -	actual -
19. Vacuum break operation	ok X	problem
20 Air cleaner	ok X	changed
21. Adjust idle mixture to specs.		done
22. Idle speed	spec. 600 D	actual 635
23. Fast idle speed	spec. 1600	actual 1600

Miscellaneous

24. Manifold heat valve	ok X	problem
25. PCV System	ok X	problem
26. EGR Valve	ok X	problem

VEHICLE CHECKLIST APPENDIX C-3

Vehicle Mfr.: Ford Year: '79 Model: Pinto Color: Peach VIN: 9T11V186165

Technician/Mechanic: 35694 Date: 2-24-84

1. Install fuel drain		done X	
2. Thermocouple fuel cap for mid-volume fuel temp. when 40% filled		done X	
3. Pressure check fuel system	start 15'	In.H_2O after 5min. 19'	
4. Change engine oil and filter	done	not necessary X	
5. Check differential fluid	ok X	topped off	
6 Check power steering fluid	ok X	topped off	
7. Check transmission fluid	ok X	topped off	
8. Check brake fluid	ok X	topped off	
9. Exhaust system	no leaks X	leaks	
10. Install boot on tailpipe		done X	
11. Canister and hoses visual check	ok X	problem	
12. Brake test	ok X	needs repair	

Ignition System

13. Points: a) dwell		spec –	actual –	
b) resistance		ok X	bad	
c) timing	spec 20°	@rpm 600 dr	actual 20°	@rpm 650 dr
d) advance		functions X	no good	
14. Plugs, Wires and Cap- Scope Check		ok X	problem	
15. Battery		ok X	problem	

Fuel System

16. Choke setting	spec. –	actual –
17. Choke operation	ok X	problem
18. Vacuum break setting	spec. –	actual –
19. Vacuum break operation	ok X	problem
20 Air cleaner	ok X	changed
21. Adjust idle mixture to specs.		done
22. Idle speed	spec. 800	actual 808 rpm
23. Fast idle speed	spec. 2000	actual 2027 rpm

Miscellaneous

24. Manifold heat valve	ok N/A	problem
25. PCV System	ok X	problem
26. EGR Valve	ok X	problem

VEHICLE CHECKLIST APPENDIX C-4

Vehicle Mfr.: Olds Year: 79 Model: Cutlass Color: Carmel VIN: 3R47A9M523280

Technician/Mechanic: 35694 Date: 2-24-84

1. Install fuel drain		done X
2. Thermocouple fuel cap for mid-volume fuel temp. when 40% filled		done X
3. Pressure check fuel system	start 16'	In.H_2O after 5min. 18'
4. Change engine oil and filter	done	not necessary X
5. Check differential fluid	ok X	topped off
6 Check power steering fluid	ok X	topped off
7. Check transmission fluid	ok X	topped off
8. Check brake fluid	ok X	topped off
9. Exhaust system	no leaks X	leaks
10. Install boot on tailpipe		done X
11. Canister and hoses visual check	ok X	problem
12. Brake test	ok X	needs repair

Ignition System

13. Points: a) dwell	spec N/A	actual
b) resistance	ok X	bad
c) timing spec 15°	@rpm 600	actual 15° @rpm 600
d) advance	functions X	no good
14. Plugs, Wires and Cap- Scope Check	ok X	problem
15. Battery	ok X	problem

Fuel System

16. Choke setting	spec. -	actual -
17. Choke operation	ok X	problem
18. Vacuum break setting	spec. X	actual
19. Vacuum break operation	ok X	problem
20 Air cleaner	ok X	changed
21. Adjust idle mixture to specs.		done
22. Idle speed	spec. 550	actual 550 drive
23. Fast idle speed	spec. 2200	actual 2218

Miscellaneous

24. Manifold heat valve	ok X	problem
25. PCV System	ok X	problem
26. EGR Valve	ok X	problem

Appendix D-1
Individual Test Results

Canister	Fuel	Prep Cycle	Test Number	Diurnal HC (g/test)	Hot Soak HC (g/test)
1974 Buick Century					
Installed	Indo.	B	84-2315	4.62	10.47
Installed	Indo.	B	84-2279	6.38	11.02
Installed	Comm.	B	84-2280	17.09	30.92
Installed	Comm.	B	84-2281	17.39	23.81
Removed	Indo.	B	84-2416	22.46	15.92
Removed	Comm.	B	84-2859	36.59	27.32
1975 Chevrolet Nova					
Installed	Indo.	B	84-1908	2.49	10.89
Installed	Indo.	B	84-1909	2.67	9.12
Installed	Comm.	B	84-2350	9.23	30.662
Installed	Comm.	B	84-2410	11.17	32.40
Removed	Indo.	B	84-2764	19.33	19.95
Removed	Comm.	B	84-2765	34.31	34.86
1971 Ford Pinto					
Installed	Indo.	LA-4	82-2399	0.11	0.50
Installed	Indo.	LA-4	84-0186	0.28	0.73
Installed	Indo.	LA-4	84-0187	0.30	0.81
Installed	Comm.	LA-4	84-0188	0.48	0.48
Installed	Comm.	LA-4	84-0377	0.25	0.25
Removed	Indo.	B	84-0378	10.25	9.73
Removed	Comm.	B	84-2630	15.16	12.18
1979 Oldsmobile Cutlass					
Installed	Indo.	LA-4	82-2397	1.80	1.85
Installed	Indo.	LA-4	84-0181	1.98	1.70
Installed	Comm.	LA-4	84-0182	2.81	1.68
Installed	Comm.	LA-4	84-0183	12.65	1.48
Installed	Comm.	LA-4	84-0184	6.03	1.83
Removed	Indo.	B	84-2766	21.33	12.60
Removed	Comm.	B	84-2767	35.53	17.48

Appendix D-2
Individual Test Results

Canister	Fuel	Prep Cycle	Test Number	Diurnal HC (g/test)	Hot Soak HC (g/test)
1983 Olds Wagon					
Installed	Indo.	LA-4	84-0862	0.65	2.49
Installed	Indo.	LA-4	84-0863	0.79	2.98
Installed	Comm.	LA-4	84-0864	2.98	4.60
Installed	Comm.	LA-4	84-0865	7.00	4.08
Removed	Indo.	B	84-2439	19.12	7.41
Removed	Comm.	B	84-2440	32.98	13.79
1983 Plymouth Reliant					
Installed	Indo.	LA-4	84-0383	1.28	1.27
Installed	Indo.	LA-4	84-0384	.97	1.40
Installed	Comm.	LA-4	84-0387	2.58	1.20
Installed	Comm.	LA-4	84-0183	2.94	2.03
Removed	Indo.	B	84-2457	10.97	11.22
Removed	Comm.	B	84-2441	18.52	20.66