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Technical Support Report for Regulatory Action

Automotive Industry Effort to Comply with a 2.0 g/test Evaporative Emission Regulation

by

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Standards Development and Support Branch
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U.S. Environmental Protection Agency

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Introduction

On Jaunary 13, 1976, a Notice of Proposed Rule Making (NPRM) for evaporative emission from 1978 and 1979 model year light duty vehicles and trucks was published in the Federal Register (Vol. 41, No. 8). This publication proposed an evaporative emission standard of 6.0 g/test for the 1978 model year and 2.0 g/test standard for the 1979 model year.

Comments on the NPRM were received from 13 automotive manufacturers. These comments contained a modest amount of data from test work conducted in attempt to achieve low evaporative emission levels. Some of the submitted test results were below 2.0 g/test, and several tests closely approached this level of control.

In June 1976 a report by Exxon Research and Engineering Company on evaporative emission control was published.[1] This report described a test program in which six production vehicles were modified in order to lower evaporative emissions. In the final modified configuration, each of these vehicles had an evaporative emission level of less than 2.0 g/test.

On September 1, 1977 (approximately six months after comments had been received on the NPRM) letters were sent to the automotive manufacturers who had commented on the evaporative NPRM. This letter requested up-to-date information regarding their efforts in meeting the proposed 2.0 g/test level of control. The manufacturers were asked to submit test data and information on control system configurations and cost. Manufacturers from which this information was requested were:

American Motors
British Leyland
Chrysler
Fiat
Ford
General Motors
International Harvester
Mercedes-Benz
Nissan
Toyo Kogyo
Toyota
Volkswagen
Volvo

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[1] "Investigation and Assessment of Light-Duty Vehicle Evaporative Emission Sources and Control", P.J. Clarke, EPA-460/3-76-014.

Test Results and Cost Information

Of the thirteen manufacturer's which were asked for recent evaporative emission control information, responses were received from seven. These seven were British Leyland, Chrysler, Ford, General Motors, Toyo Kogyo, Toyota, and Volvo. Of these seven responses, two (General Motors and Toyo Kogyo) contained no test data. GM stated that they were encountering previously unknown problems in regard to meeting the 1978 evaporative standard at high altitude. Their development efforts have been concentrated in that area and they could not add significantly to the data previously submitted. Similarly, Toyo Kogyo stated that they have been occupied with development of systems to meet the 6.0 g/test standard for 1978.

Test information which was submitted by the other five manufacturers is contained in Appendix A as Attachments A-I through A-V. Attachment A-I contains results of sixteen development tests conducted by Chrysler on stock and modified 1978 California prototype control systems. As shown, the nine tests conducted on passenger cars with non-stock systems ranged from 2.04 to 5.55 grams. It appears that controlling emissions from vehicles with larger fuel tanks is more difficult, since the three vehicles tested with large fuel capacity (36 to 41 gallons) had emissions ranging from 7.14 to 22.01 grams.

Data submitted by Ford is contained in Attachment A-II. Tests on 21 vehicles are presented, and six of these had average evaporative emissions of less than 2.0 g/test. All 21 vehicles were equipped with the 1978 production evaporative control system, which has a design level of 3.0 g/test.

Attachment A-III is a list of the test results submitted by Toyota. The emission levels are average values for five vehicles designed to meet the 1978 6.0 g/test standard. As shown the vehicle averages range from 2.8 to 4.8 g/test. Toyota estimates that the cost increase for these evaporative control systems will range from $10.75 to $14.75 per vehicle on all engine types except one. For that engine they will also use an underhood ventilating fan which costs another $25.

Attachment A-IV contains the data supplied by Volvo. These vehicles were all equipped with the production continuous fuel injection system. As shown, a substantial reduction in evaporative emissions was achieved by reducing the fuel tank pressure. The 1977 production system has a fuel tank to charcoal canister pressure relief valve with a setting of 24 kPa (3.5 psig). When this valve was removed, the maximum fuel tank pressure encountered during testing was 3 kPa (0.4 psig) and all of the four vehicles tested at low altitude had evaporative emissions less than 2.0 g/test. Interestingly, removal of the pressure relief valve on the one vehicle tested at high altitude (approximately 5300 ft) increased evaporative emissions significantly. As shown in Attachment A-IV, use of a larger canister and increasing the canister purge rate on the Volvo vehicles reduced evaporative emissions. In regard to cost, Volvo stated

that use of a differently calibrated tank pressure relief valve and increasing the purge rate would be no cost modifications. Increasing the canister capacity by 66% would cost an estimated $2.50.

Attachment A-V contains the data submitted by British Leyland. These are carbureted vehicles. In current production configuration, vehicle type A appears to emit less than 2.0 g/test.

Discussion

The data and comments received from the manufacturers indicate that very little effort has been directed at developing systems targeted at evaporative emission levels of 2.0 g/test.

The low level of effort which has been directed toward achieving evaporative levels under 2.0 g/test is best exemplified by General Motor's response, which contained no data. GM stated that background emissions are still a real problem and a better solution than that currently offered is needed. GM also indicated that certain types of evaporative control systems may result in unsafe vehicle operation. They state that seals used to stop carburetor vapor leaks might cause throttle sticking and choke binding, and development programs must be implemented to eliminate any such problems. GM states, "We believe that the performance of 1978 model vehicles must be addressed before determining the need and cost/effectiveness of additional evaporative emission control."

Ford also did not submit any data on vehicles which were designed or modified in an attempt to meet a 2.0 g/test evaporative emission level. However, Ford did state that they are currently engaged in a program to determine whether available technology could support a 2 g/test standard. This program consists of establishing background levels, establishing emission levels and sources from their 1978 control systems, and developing systems to totally eliminate evaporative losses. Currently, background tests are being conducted and system components are being designed and procured. Ford states that they plan to finish this program by about March, 1977.

Along with their test data, Chrysler stated that their efforts have been devoted almost exclusively to the development of systems to meet the 1978 evaporative standard. In the course of that development program, they have discovered no new technology which would enable them to achieve a 2 g/test level.

Like GM and Chrysler, Toyota, Toyo Kogyo and British Leyland stated that they have been concentrating their efforts on establishing evaporative emission control systems capable of meeting the 6 g/test standard. Toyota stated that they are now planning to reinvestigate the structure of their canister and the possibility of using the air cleaner for vapor storage.

Because of the fuel injection system on their vehicles, Volvo appears to have the evaporative emission problem quite well in hand.

Their current equipment development and testing consists of improving leak tightness of ECS and FI systems, determining an optimum fuel tank pressure relief setting, and determining optimum canister size and purge rate.

Summary

Since receiving comments on the 1978-79 evaporative emission NPRM, it appears that there has generally been very little manufacturer development effort targeted to meet a 2.0 g/test evaporative emission level. By letter, thirteen manufacturers were asked to supply up-to-date information regarding their efforts since the evaporative NPRM comment submittal. Seven of these manufacturers responded. Of these seven only one domestic manufacturer (Ford) stated that it was engaged in a development program aimed at designing a control system which would meet a 2.0 g/test standard. To date, Ford hasn't conducted any vehicle tests in this program. However, Ford's tests on 21 vehicles equipped with the 1978 control system did show that six of these vehicles had evaporative levels less than 2.0 g/test.

One foreign manufacturer (Volvo) is doing development and testing to achieve very low evaporative levels. Largely due to the configuration of their engine fuel system (fuel injection) they have been successful in achieving evaporative levels less than 2.0 g/test on all five vehicles on which they have submitted test data.

Appendix A - Test Data

Attachment A-I

Chrysler Data

TABLE 1

1976 CHRYSLER EVAPORATIVE
SYSTEM DEVELOPMENT TESTS TO DATE

Test Number		Conclusions	Car	Eng.	Prototype Emission Package	Total	Hot Soak	Diurnal
47-76	Stock*	Baseline	F610	225-1	1978 California	12.75	12.24	0.51
49-76	External Bowl Vent	Good	F610	225-1	1978 California	2.04	0.98	1.06
184-76	Stock*	Baseline	F610	225-2	1978 California	13.23	12.42	0.81
243-76	External Bowl Vent	Adequate	F610	225-2	1978 California	3.53	1.79	1.74
141-76	Stock*	Baseline	B536	318-2	1978 California	11.83	11.32	0.51
416-76	External Bowl Vent. Carter Carb. High Purge Rate.	Adequate	B536	318-2	1978 California	3.22	1.97	1.25
317-76	Bowl Vent. Holley Carb. High Purge Rate.	Barely Adequate	B536	318-2	1978 California	4.74	3.77	0.97
57-76	Stock*	Baseline	F235	360-2	1978 California	6.28	5.69	0.59
364-76	External Bowl Vent	Adequate	F235	360-2	1978 California	3.33	1.58	1.75
197-76	2-Way Bowl Vent	Not Adequate	B202	360-4	1978 California	5.55	3.51	1.98
365-76	2-Way Bowl Vent. High Purge Rate.	Adequate	B202	360-4	1978 California	3.46	2.03	1.43
438-76	2-Way Bowl Vent. High Purge Rate. Vapor Volume Storage.	Adequate	C593	440-4	1978 California	3.36	1.50	1.86

*Stock is prototype 1978 California exhaust emission system with 1977 "carryover" evap. emission system.

TABLE 1
Cont.

Test Number	Hardware Changes	Conclusion	Car	Eng.	Emission Package	Total	Hot Soak	Diurnal
455-76	External Bowl Vent. High Purge Rate. Heat Shields. Special Canister.	Not Adequate	L554	1.7 liters	1978 California	4.44	3.00	1.44
468-76	2-Way Bowl Vent. High Purge Rate. Vapor Storage Volume.	Not Adequate	D328	360-2 41 Gal. Dual Tanks	1978 California	22.01	5.74	16.27
462-76	External Bowl Vent. High Purge Rate. Vapor Storage Volume.	Not Adequate	D261	225-2 36 Gal.	1978 California	7.14	3.04	4.10
469-76	External Bowl Vent Intersecting Vapor Storage Volume.	Not Adequate	B296	360-2 36 Gal.	1978 California	7.90	2.39	5.51

Ford Data

SHED Data (gm/test) - 1978 Ford Evaporative Emission System

Vehicle No.	Engine CID/L	1	2	3	4	5	6
1	2.3	1.30	1.40				
2	2.3	3.24	3.79	3.99	4.02		
3	2.8	3.14	3.35	2.93	3.12	3.38	2.79
4	2.8	4.18	1.54	2.45			
5	200	1.80	3.90	2.30			
6	200	1.57	1.89				
7	250	1.11	1.06	1.06			
8	250	0.70	1.99	2.21			
9	250	0.82	0.90	2.45			
10	300	2.76	2.91	2.35	2.43		
11	300	2.91	2.76	2.43	2.35	3.19	3.01
12	300	5.25	1.92	7.35	2.41		
13	300	2.21	2.23	1.95			
14	302	3.04	2.83	1.99	2.94	2.51	2.95
15	302	3.95	3.66	2.49			
16	302	2.37	2.45				
17	302	3.31	2.61				
18	351	2.44	2.21	2.25	2.56		
19	351	1.57	1.15				
20	400	2.66	2.50	2.00			
21	400	2.21	2.50	2.19			

Table 1 Average Evaporative Emissions and Exhaust Emissions

Item \ Model		Corolla (49 States)	Corolla (49 States)	Corolla (California)	Corona (49 States)	Land Cruiser (49 States)
Evaporative Emission (g/mile)	Diurnal	3.2	1.8	1.8	2.3	3.8
	Hot Soak	1.2	1.0	1.0	0.9	1.0
	Total	4.4	2.8	2.8	3.2	4.8
Exhaust Emission (g/mile)	HC	0.94	0.77	0.28	0.54	1.06
	CO	7.8	12.4	4.8	12.6	17.8
	NOx	1.3	1.3	1.1	1.6	1.8
Number of Test		5	11	12	3	1
Engine		3K-C	2T-C	←	20R	2F
Displacement (cu.in)		71.2	96.9	←	133.6	257.9
Charcoal volume (cc)		1300	←	←	←	1400
Purge Control		Throttle Opening	Throttle Opening & Coolant Temp.	Vehicle Speed	Vehicle Speed & Coolant Temp.	←
Purge to		Carburetor	←	Intake Manifold	←	←
Emission Control System		AS + EGR + CCo	AS + EGR + CCo	AI + EGR + CCo	AI + EGR	←

(Note) AS : Air Suction (pulse injector)
AI : Air Injection
EGR : Exhaust Gas Recirculation
CCo : Catalytic Converter for Oxidation

Attachment A-IV

Volvo Data

Vehcile	Test Site	Control System	Total Emissions, g
1	Volvo	(1)	2.22
		(2)	1.75
		(3)	0.93
2	Volvo	(1)	4.84
		(3)	1.50
		(2)(3)	0.94
3	Volvo	(1)	5.90
		(3)	1.38
4	Volvo	(1)	1.47
		(3)	0.82
5	ATL (Denver)	(1)	2.95
		(3)	9.53
		(4)	1.17

(1) 1977 production
(2) Increased purge rate
(3) Decreased fuel tank pressure setting
(4) 1.0 liter canister in place of standard 0.6 liter canister

Attachment A-V

British Leyland Data

Vehicle Type	Control System	Diurnal, g	Hot Soak, g	Total, g
A	(1)	0.7	1.0	1.7
	(1)	0.8	0.8	1.6
A	(1)		1.58	
	(1)		1.93	
	(2)		1.18	
B	(1)	0.8	2.9	3.7
	(1)	0.1	3.8	3.9
C	(1)	3.0(3)	23.3(4)	26.3
	(1)	1.3	18.5	19.8
D	(1),(5)	2.7	10.1	12.8
E	(1)		2.05	

(1) Production System
(2) Modified 1977 California System
(3) Hydrocarbons escaping from canister
(4) Line from carburetor to canister was wet at end of hot soak
(5) High mileage vehicle