Technical Support for Regulatory Action
In-House Test Program
Report No. 6 -
Hot Soak Time Constraints

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Notice

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1. Introduction

The object of the in-house evaporative emission enclosure (SHED) test program is to develop a concise, accurate, and practical evaporative emission test procedure. One of the tasks identified for the test program was to establish a recommended time from the end of the dynamometer test cycle to the start of the hot soak evaporative emission test. This report will discuss the data which were gathered to fulfill this task. The objective of this report is to use the collected data to establish the effect of the time between the exhaust emissions and hot soak emissions test phases on the measured evaporative emission levels during the hot soak and to recommend a time tolerance based on this information and practical considerations.

2. Summary and Conclusions

The time tolerances of two operations prior to the hot soak evaporative emissions test were evaluated. They were:

a) The time from the end of the exhaust test cycle to engine shutdown (idle time); and

b) The time from engine shutdown to the start of the hot soak test.

The first evaluation involved allowing a vehicle to idle for 2, 4, 6 or 8 minutes, and then measuring carburetor bowl temperatures and hydrocarbon losses during the one hour hot soak following engine shutdown. The results of this testing showed that while initial bowl temperatures were higher for longer idle times, the peak bowl temperatures were the same. There was no trend of increasing emissions with increasing idle times. It is recommended that this time be specified at a 4 minute maximum time tolerance. Experience obtained during the testing program indicates that this will not be a difficult time tolerance to achieve in production.

The evaluation of the time delay from engine shutdown to the start of the hot soak test consisted of measured hot soak emissions on 6 test vehicles. The error resulting from a time delay of one minute was estimated using hydrocarbon loss data from the first and last minute of the 60 minute hot soak test. The results indicated that errors as large as 2% can result from a one minute time delay. Depending on the relative rates of hydrocarbon evolution at the start and end of the hot soak test, longer delays may cause even larger errors in the hydrocarbon measurement. A time tolerance for this operation of less than one minute is not practical, however. Therefore, it is recommended that a time tolerance of 1.0 minute be established for the key-off to the start of the hot soak test operation.

3. Technical Discussion

The time tolerance between the end of the dynamometer run and the start of the hot soak test recommended in the SAE J171a(1) test procedure is 3 min. $\pm$ 15 seconds. The hot soak test described by the SAE J171a procedure is assumed to start at engine shutdown. This definition of the start of the hot soak is difficult to use in practice since:

a) It is undesirable to drive the vehicle into the enclosure; and

b) After the engine is turned off, some time is required for the driver to leave the enclosure and for the enclosure doors to be closed.

Therefore, two time tolerances need to be established:

a) The time from the end of the dynamometer test to key-off; and

b) The time from key-off to the start of the hot soak test.

A practical sequence of events for these operations would be as follows:

a) At the end of the dynamometer test, prepare the vehicle to be moved to the SHED, but <u>don't</u> turn the engine off;

b) Drive the vehicle at minimum throttle to the SHED and stop a few feet short of the SHED doors;

c) Turn the engine off and push it into the SHED;

d) The start of the hot soak is indicated at the time the doors of the SHED have been sealed.

This sequence of events prevents excessively high initial hydrocarbon readings due to exhaust gases entering the SHED, but still allows a quick and easy way of moving the vehicle off of the dynamometer to the SHED.

A question which should be answered is, what effect does the time between the end of the exhaust test and engine-shutdown (idle time) have on subsequent hot soak emission values. If this engine idling time without the benefit of a cooling fan is extended too long, then higher vehicle temperatures may result, causing higher emission levels. The effect of this time will also be evaluated during testing.

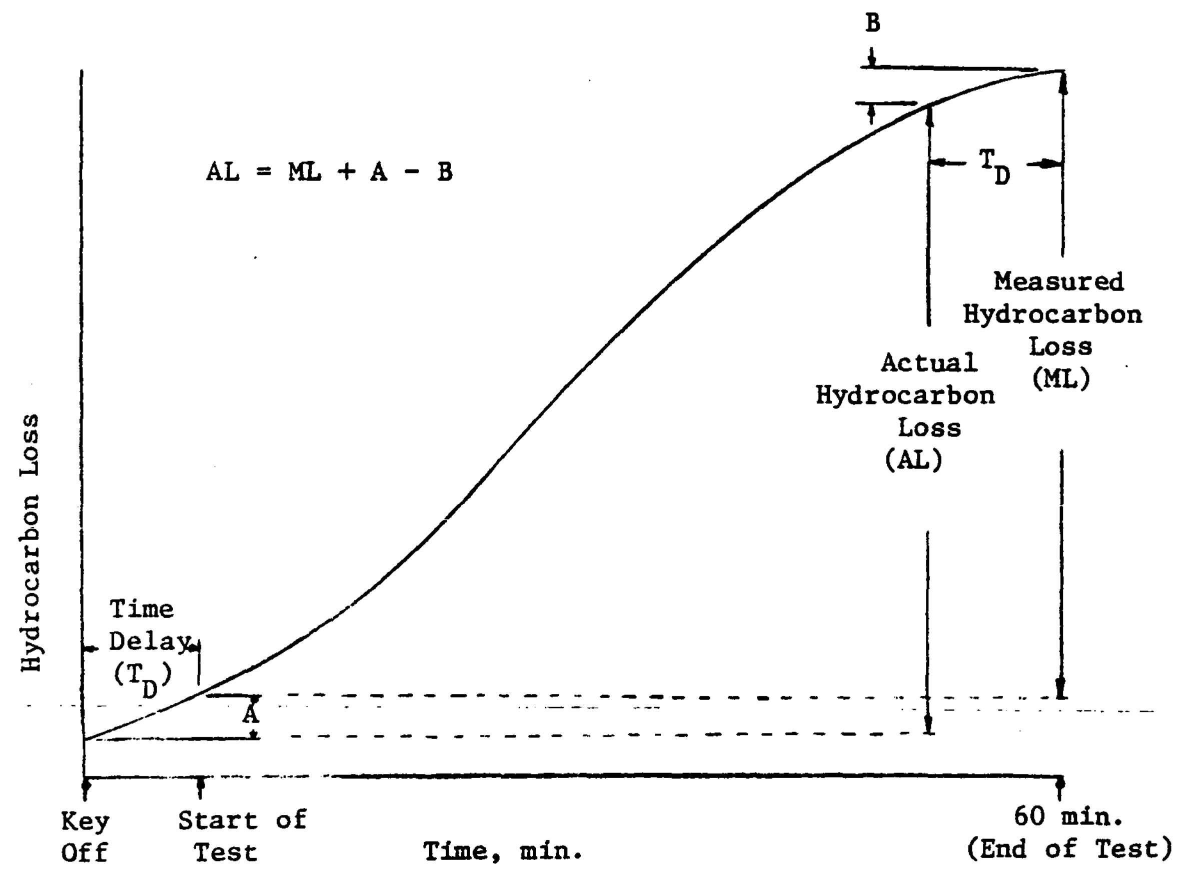

Figure 3-1. Typical Hydrocarbon vs. Time plot for a one hour hot soak.

Another point of concern that also requires evaluation is, what error is introduced in the calculation of hot soak emission levels due to the time between engine shutdown and the start of the test. Figure 3-1 shows a typical hydrocarbon versus time plot for a 1 hour hot soak. The actual 1 hour hot soak losses (AL) can be expressed as the measured hydrocarbon loss (ML) plus the hydrocarbon loss (A), occurring during the time delay (T_D), minus the additional hydrocarbon loss (B) measured during a time equal to the time delay at the end of the test. The percent error between the actual and the measured hydrocarbon loss can be expressed as follows:

$$\% \text{ ERROR} = \frac{\text{Actual loss (AL)} - \text{Measured loss (ML)}}{\text{Actual loss (AL)}} \times 100$$

$$\% \text{ ERROR} = \frac{(ML + A-B) - ML}{(ML + A-B)} \times 100$$

$$\% \text{ ERROR} = \frac{A-B}{ML + A-B} \times 100$$

Thus, the error associated with a given time delay can be evaluated if A, B, and ML are known. For testing conducted in the enclosure, only ML and B can be measured. It is impossible to determine the hydrocarbon loss prior to vehicle entry into the SHED. If one assumes, however, that the rate of hydrocarbon loss during the time delay is the same as the loss rate at the beginning of the test, one can use the data gathered in the first minute or so of the test to approximate the value of A. This method of predicting the errors associated with the time delay should give a reasonably accurate estimate of the error resulting from a short time delay, and it will be used to evaluate data gathered during hot soak tests on six vehicles.

3.1 Program Objective

The purpose of this study is to evaluate the effect of the time between the end of the exhaust test and engine shutdown and between engine shutdown and the start of the hot soak test, on hot soak emission levels. By use of this evaluation and consideration of practical limitations, time tolerances for this portion of testing will be recommended.

3.2 Program Design

In order to evaluate the effect of the time between:

a) The end of the exhaust test and engine shutdown (idle time); and

b) Engine shutdown and the start of the hot soak test,

two types of evaluations were made. To evaluate the effect of the idle time, replicate tests were performed on an F-100 pick-up truck using idle times of either 2, 4, 6, or 8 minutes duration. The time delay from engine shutdown to the start of the test was monitored, along with vehicle temperatures and hydrocarbon concentration in the enclosure, during a one hour hot soak. The concern over the length of the idle time is due to the possibility of differences in peak carburetor bowl temperatures, which could cause differing amounts of fuel to be distilled from the carburetor bowl. Therefore, of particular interest are the carburetor bowl temperature data gathered during this testing. Vehicles were tested using the sequence of events described at the beginning of this section and, therefore, testing should give insight into the difficulty of moving the vehicle off the dynamometer to the enclosure in the alotted time, using that sequence of events.

Data gathered during the tests described above and during tests on five other vehicles used in other evaporative emission related studies were used to evaluate the effect of the time delay from engine shutdown to the start of the hot soak test. This evaluation was based on estimating errors using the method described earlier. Hydrocarbon emissions were measured continuously over the one hour period. Losses during the first minute and last minute of the test were calculated, along with the loss during the entire one hour test.

3.3 Facilities and Equipment

3.3.1 Enclosure

The LDV Evaporative Enclosure as shown in Figure 3-2 was used for all evaporative emission tests. The enclosure is nominally 8 feet high x 10 feet wide x 20 feet long and has a measured volume of 1540 ft^3. Calculation of the enclosure volume with a propane injection and recovery test compared within $\pm$ 2 percent of the measured volume. Propane retention tests of 2 and 4 hours were performed periodically and indicated a leakage rate of less than 0.1 g/hr. The enclosure is approximately 50 ft. from the dynamometer used during testing.

Figure 3-2 LDV Evaporative Enclosure

3.3.2 Test Vehicles

The six 1975 my vehicles used during testing are described in Table 3-1. The criteria for selecting vehicles was that they had accumulated 4000 miles and had been in use for over 90 days.

3.3.3 Test Fuel

Indolene Type HO lead-free test fuel was used.

Make	Chevrolet	Chevrolet	Chrysler	AMC	Volkswagon	Ford
Model	Vega	Camaro	New Yorker	Matador	Beetle	F-100 Truck
VIN	IV77B5U113062	IQ87H5N511341	LS23T5C110951	A56167P15041	1352038245	17M-899
Disp/Cyl Displacement	140-I4	350-V8	440-V8	360-V8	97 - I4	302-V8
Transmission	4-speed	Automatic	Automatic	Automatic	4 - speed	Automatic
Air Cond.	no	yes	yes	yes	No	No
Ign. Timing	10°BTDC	6°BTDC	8°BTDC	5°BTDC	5° ATDC	12° BTDC
Idle RPM	700	600	750	700	875	550
Tires	A78-13	FR-7814	JR78-15	HR78-14	6.00 - 15L	G78-15
Carb. Model	Holley	Rochester	Carter	Motorcraft	-	Autolite
Venturis	2	2	4	4	-	2
Fuel Bowl Size	38.5 cc	72 cc	160 cc		-	110 cc
Fuel Tank Vol.	16.0 gal	21.0 gal	26.5 gal	24.5 gal	11.0 gal	39.4 gal.
Inertia Wt.	2750	4000	5000	4500	2250	4000
Dyno H.P.	9.9	12.0	13.4	12.7	8.8	12.0
Exhaust Sys.	EGR Catalytic Reactor	EGR Catalytic Reactor	EGR Catalytic Reactor (dual)	EGR-AIR Catalytic Reactor (dual)	EGR Fuel injection	EGR Catalytic Reactor Air
Evap. Sys.	Canister	Canister	Canister	Canister	Canister	Canister

Table 3-1 Description of Test Vehicles

3.3.4 Other Equipment

Hydrocarbon concentration in the enclosure was measured continuously with a Beckman 400 Flame Ionization Detector (FID). Temperature measurements were made with type "J" (iron-constantan) thermocouples and recorded on an Esterline Angus temperature recorder.

3.4 Test Procedures

Testing for the evaluation of the effect of idle time was conducted as follows:

(a) Vehicle was driven over a 1972 exhaust emission test cycle;

(b) At the end of the test cycle a timer was started, the vehicle removed from the dynamometer, and driven to within 10 ft. of the enclosure;

(c) After either 2, 4, 6, or 8 minutes had elapsed from the end of the exhaust test cycle, the engine was shutdown;

(d) The vehicle was immediately moved into the enclosure and the doors were sealed. The time from engine shutdown to the start of the hot soak test was recorded;

(e) A one hour hot soak test was conducted in the enclosure. Carburetor bowl temperatures and hydrocarbon concentration in the enclosure were measured.

Testing for the evaluation of the effect of the time delay between engine shutdown and the start of the hot soak test was performed as follows:

(a) Vehicles were driven over a 1975 exhaust emission test cycle (except the F-100 truck);

(b) At the end of the exhaust test cycle the vehicle was driven to the enclosure;

(c) The engine was shutdown and the vehicle was immediately pushed into the enclosure. The doors were sealed which coincided with the start of the test. Hydrocarbon concentration in the enclosure was monitored continuously.

4. Test Results

4.1 Effect of Idle Time

Four replicate tests at each of the 4 idle times (2, 4, 6, and 8 minutes) were conducted on the Ford F-100 truck. Carburetor bowl and hydrocarbon loss data gathered during the one hour hot soak for these 16 tests are given in Appendix A.

Figure 4-1 shows the carburetor bowl vs. time plots for each of the four idle times. The time delay from engine shutdown to the start of the test was measured and is reflected by the time shown in the curves. The figure shows that, while the initial temperatures were higher for the longer idle times, the peak carburetor temperatures were roughly the same.

Figure 4-2 shows the average one hour hot soak losses for each of the 4 idle times and the range of data at each of the idle times. No trend can be firmly established from these data.

4.2 Effect of Time Delay After Engine Shutdown

Either three or four replicate tests were performed for each of the six test vehicles. Hydrocarbon loss data at each ten minute interval and at the end of the first and fifty-ninth minutes are presented in Appendix B, for the twenty tests conducted.

Figure 4-3 is a hydrocarbon loss versus time plot for each of the six vehicles. It illustrates the differences in the loss rate during the the one hour, for different vehicles. A general statement concerning the effect of time delay cannot be made. For some vehicles, the time delay may result in higher emissions than the emissions during the "actual" hour after engine shutdown. For other vehicles the opposite may be true. Which effect will occur depends on the relative magnitude of the initial and final hydrocarbon emission rates.

Table 4-1 gives the hydrocarbon loss during the first and last minutes of the hot soak test and during the entire 60 minute test. This information is used to approximate the error due to a one minute time delay, by the method discussed in section three of this report. These percent errors are also given in Table 4-1. A positive error indicates that the actual losses were higher than the measured losses, and a negative error indicates that actual losses were lower than the measured losses. This table shows that both positive and negative errors occurred but that negative errors occurred most often.

5. Discussion of Test Results

5.1 Effect of Idle Time

The carburetor bowl temperatures measured for each of the four idle times showed two things:

a) The longer the idle time the higher the initial temperatures; and

b) Peak carburetor bowl temperatures were roughly the same.

Higher initial temperatures should have little effect on the resulting losses. A somewhat higher initial emission rate may result,

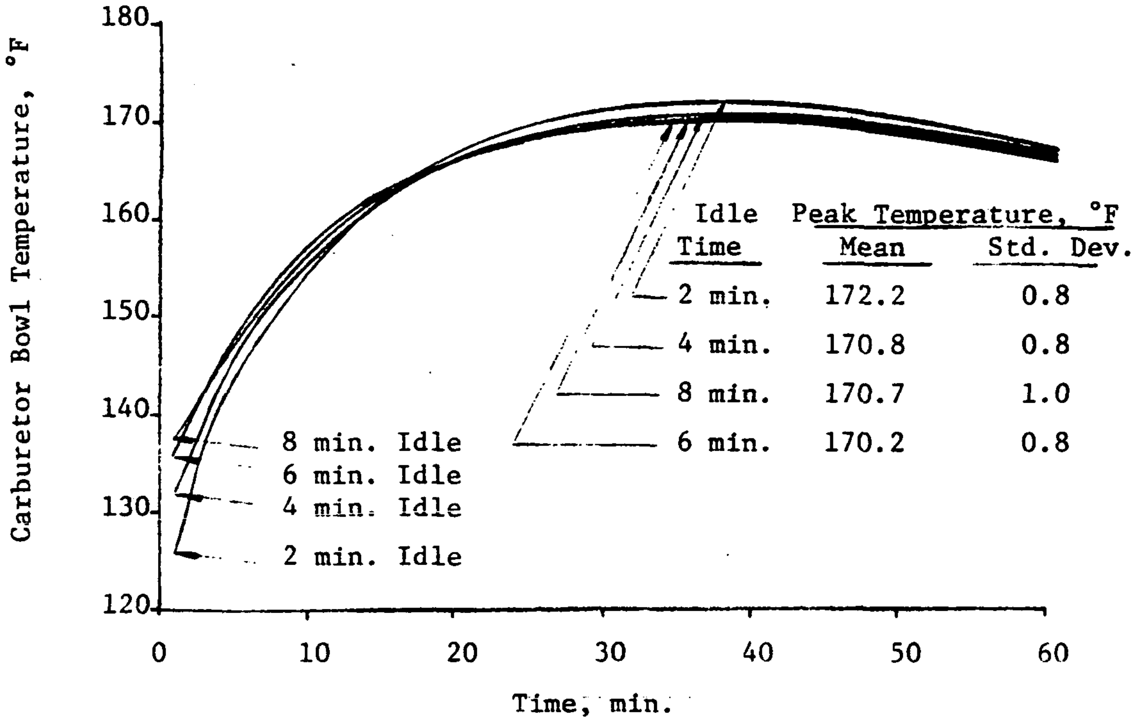

Figure 4-1 Carburetor Bowl Temperature vs. Time for Different Idle Times.

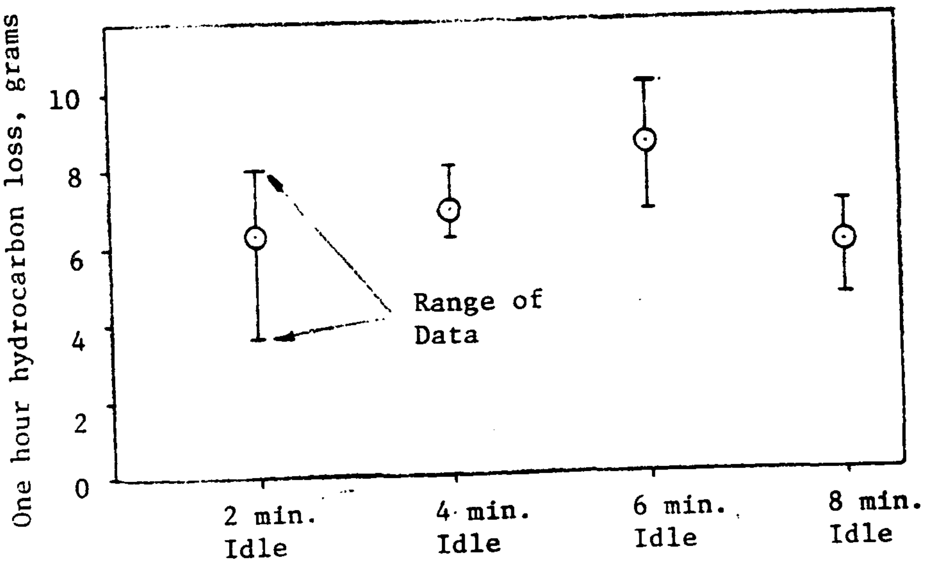

Figure 4-2 Hydrocarbon Loss Data for Different Idle Times.

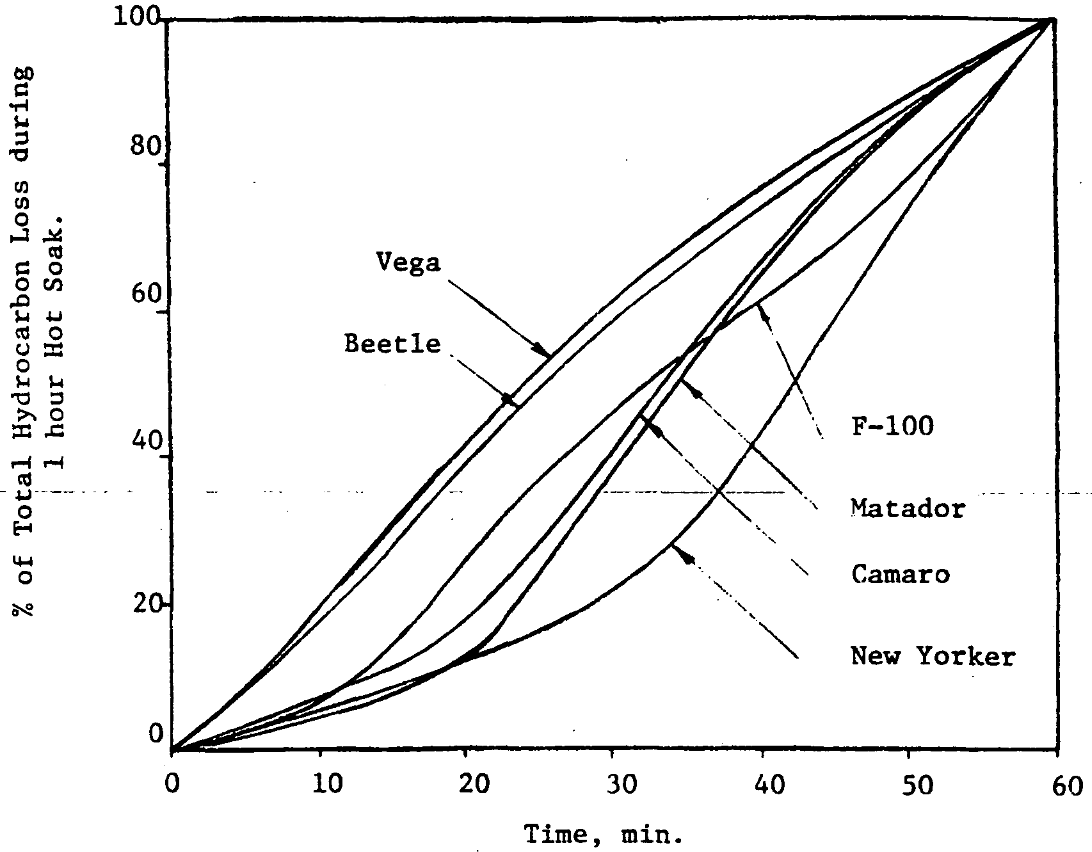

Figure 4-3 % Hydrocarbon Loss vs. Time for 6 test vehicles.

Vehicle	Test No.	Hydrocarbon Loss, grams During first Minute (4)	During last Minute (8)	During one Hour Test (ML)	% Error
	021	.0141	.0139	1.18	0.017
Vega	022	.0138	.0210	1.07	-0.677
	023	.0139	.0138	0.89	0.011
				Average Error	-0.216%
	014	.0558	.0566	4.88	-0.016
Camaro	016	.0633	.0559	5.15	0.143
	017	.0410	.0559	5.28	-0.283
				Average Error	-0.052%
	024	.0638	.149	14.1	-0.608
Matador	025	.0572	.149	14.3	-0.645
	026	.1427	.191	17.6	-0.274
				Average Error	-0.509%
	094	.0365	.0283	2.58	0.317
Beetle	097	.0364	.0317	2.46	0.191
	101	.0362	.0316	2.37	0.194
				Average Error	0.234%
	030	.0426	.183	6.25	-2.30
	032	.0353	.214	7.26	-2.52
New Yorker	034	.0481	.213	10.33	-1.62
	036	.0478	.181	9.09	-1.49
				Average Error	-1.98%
	263	.064	.169	6.24	-1.71
	264	.086	.150	6.52	-0.99
F-100	265	.017	.170	8.09	-1.93
	266	.042	.148	7.13	-1.51
				Average Error	-1.54%

Table 4-1 Error Analysis of Errors Associated with Time Delay fter Engine Shut Down

but during the course of the one hour test the peak temperatures should be the controlling factor. If this is the case, then the time limitation from the end of the exhaust test cycle should be established such that adequate time is allowed so that no test result is voided due to the inability to meet the required time limit. Part of the test design called for hot soak tests to be conducted with a 2 min. idle time. The fact that a 2 minute idle time was used during this testing indicates that it is possible to perform the test in this time frame. Experience shows that in practice, this is not an easy time limit to live with, however. Figure 5-1 is a histogram of idle times for 27 evaporative emission tests performed in conjunction with several ather test evaluation tasks at EPA. These data should indicate a more typical testing condition than the special idle time tests performed for this report. The figure indicates that only one test surpassed an idle time of four minutes and that no test had an idle time greater than 5 minutes. It is felt that a four minute time limitation from the end of the exhaust test cycle is adequately liberal.

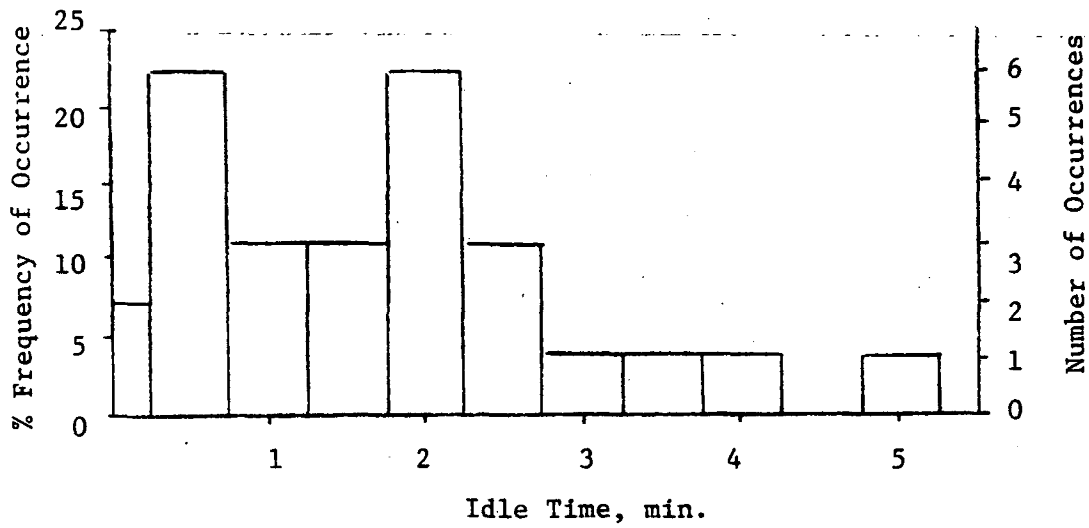

Figure 5-1 Histogram of Idle Time Data for 27 Hot Soak Tests

5.2 <u>Effect of Time Delay After Engine Shutdown</u>

The data presented in section 4 indicate that errors as large as 2% will result from a time delay of one minute. Therefore, it seems that this time delay needs to be limited as much as is practicable. The maximum time delay for tests conducted for the evaluation of the effect of idle time was 1.17 minutes and the average delay was .73 minutes with a standard deviation of .16 minutes. Therefore, if these tests are indicative of production type testing, a time tolerance of 1.0 minutes would result in 4.5% of the tests being voided due to exceeding this tolerance. These tests probably required some additional time to start due to the necessity of connecting thermocouples and monitoring times, however. In production type testing there will be no other required operation other than moving the vehicle into the enclosure and sealing the door(s). It is felt that a time tolerance much less than 1.0 minute would not be practical. Further, it is felt that a tolerance of 1.0 minute is a reasonable tolerance and a longer tolerance would result in even higher errors than those seen for a one minute time delay.

6. References

1. "Measurement of Fuel Evaporative Emissions from Gasoline Powered Passenger Cars and Light Trucks using the Enclosure Technique", SAE Recommended Practice, SAE J171a, SAE Handbook.

TEST NO.	IDLE TIME (MIN.)	TIME TO KEY-OFF (MIN.)	CARBURETOR TEMPERATURE, °F, at the Following Times During a One Hour Hot Soak											
			T= 0	T= 1	T= 2	T= 4	T= 6	T= 8	T=10	T=20	T=30	T=40	T=50	T=60
259	2	0.70	124.8	128.1	132.1	140.0	146.9	151.8	155.6	166.9	170.9	171.2	169.2	166.3
260	2	0.83	124.1	128.2	143.0	141.1	147.6	152.9	156.2	167.6	171.5	171.9	170.3	168.0
261	2	1.17	125.2	130.2	135.0	142.9	148.1	152.9	158.0	167.8	172.1	172.8	171.5	168.2
262	2	0.70	127.5	130.1	134.0	142.1	149.0	153.1	156.9	168.5	172.8	172.9	171.1	168.0
MEAN		0.85	125.4	129.1	136.0	141.5	147.9	152.7	156.7	167.7	171.8	172.2	170.5	167.6
STD. DEV.		0.2	1.5	1.2	4.8	1.3	0.9	0.6	1.0	0.7	0.8	0.8	1.0	0.9
263	4	0.63	131.7	134.9	138.8	145.7	150.6	154.4	158.1	168.0	171.1	171.8	170.1	167.2
264	4	0.67	131.1	132.5	136.7	143.4	149.0	153.2	156.5	166.2	170.1	169.9	168.0	165.4
265	4	0.62	131.8	134.1	137.3	144.8	149.6	153.8	156.9	166.5	170.5	170.8	169.2	166.5
266	4	0.70	131.4	133.7	136.8	143.8	148.9	153.2	156.6	167.1	170.5	170.9	169.6	167.0
MEAN		0.65	131.5	133.8	137.4	144.4	149.5	153.6	157.0	166.9	170.5	170.8	169.2	166.5
STD. DEV.		0.0	0.4	1.0	1.0	1.1	0.8	0.6	0.8	0.8	0.4	0.8	0.9	0.8
267	6	0.53	135.9	139.8	142.5	148.3	152.6	155.7	158.9	167.0	170.0	170.2	168.4	166.0
268	6	0.70	135.5	137.2	140.5	146.7	151.3	154.9	157.9	166.9	170.4	170.8	169.4	167.0
269	6	0.58	134.9	136.2	139.6	145.9	150.3	153.8	157.0	166.1	169.1	169.1	168.0	165.0
270	6	0.88	137.1	138.4	142.0	147.8	152.9	156.1	159.0	167.8	170.5	170.7	168.5	166.1
MEAN		0.67	135.8	137.9	141.1	147.2	151.8	155.1	158.2	166.9	170.0	170.2	168.6	166.0
STD. DEV.		0.2	0.9	1.6	1.3	1.1	1.2	1.0	0.9	0.7	0.7	0.8	0.6	0.8
271	8	0.80	139.2	140.5	143.5	149.1	153.5	156.8	159.2	168.1	171.5	172.0	170.5	168.0
273	8	0.58	137.0	137.5	140.6	146.0	150.8	154.0	156.9	166.0	169.4	170.0	168.6	166.1
274	8	0.67	137.1	139.1	141.5	147.0	151.4	155.0	157.8	166.2	169.1	169.8	168.2	166.0
275	8	0.97	136.0	137.9	140.2	146.2	151.0	154.8	157.0	166.1	170.0	171.0	169.5	167.1
MEAN		0.75	137.3	138.7	141.4	147.1	151.7	155.1	157.7	166.6	170.0	170.7	169.2	166.8
STD. DEV.		0.2	1.3	1.4	1.5	1.4	1.3	1.2	1.1	1.0	1.1	1.0	1.0	1.0

HYDROCARBON LOSSES, grams, at the Following Times During a One Hour Hot Soak.

TEST NO.	IDLE TIME	TIME TO KEY-OFF	T= 0	T= 1	T= 2	T= 4	T= 6	T= 8	T=10	T=20	T=30	T=40	T=50	T=60
259	2	0.70	0.0	0.018	0.127	0.323	0.409	0.582	0.777	1.555	1.795	2.467	3.052	3.619
260	2	0.83	0.0	0.042	0.086	0.217	0.326	0.391	0.435	1.697	2.914	3.871	4.913	6.286
261	2	1.17	0.0	0.021	0.021	0.063	0.173	0.282	0.303	2.150	3.896	5.311	6.759	8.068
262	2	0.70	0.0	0.022	0.044	0.153	0.197	0.306	0.394	1.652	3.343	4.472	5.584	6.900
MEAN		0.85	0.0	0.026	0.069	0.189	0.276	0.390	0.477	1.763	2.987	4.030	5.077	6.218
STD. DEV.		0.2	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.9	1.2	1.6	1.9
263	4	0.63	0.0	0.064	0.085	0.151	0.282	0.392	0.413	1.783	2.976	3.786	4.845	6.242
264	4	0.67	0.0	0.086	0.150	0.214	0.323	0.388	0.585	1.713	2.972	3.890	4.988	6.515
265	4	0.62	0.0	0.017	0.038	0.190	0.276	0.406	0.449	1.923	3.698	5.223	6.515	8.091
266	4	0.70	0.0	0.042	0.085	0.237	0.345	0.410	0.475	1.812	3.275	4.428	5.639	7.132
MEAN		0.65	0.0	0.052	0.089	0.198	0.306	0.399	0.480	1.808	3.230	4.332	5.497	6.995
STD. DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.7	0.8	0.8
267	6	0.53	0.0	0.041	0.126	0.212	0.342	0.449	0.513	1.713	3.100	4.218	5.453	6.831
268	6	0.70	0.0	0.038	0.101	0.163	0.205	0.357	0.441	2.087	4.213	5.793	7.231	8.856
269	6	0.58	0.0	0.056	0.098	0.202	0.287	0.415	0.499	2.222	3.935	5.789	7.454	9.092
270	6	0.88	0.0	0.062	0.170	0.235	0.364	0.429	0.581	1.875	4.517	6.263	7.772	9.525
MEAN		0.67	0.0	0.049	0.124	0.203	0.299	0.412	0.508	1.974	3.941	5.516	6.977	8.576
STD. DEV.		0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.6	0.9	1.0	1.2
271	8	0.80	0.0	0.058	0.123	0.185	0.357	0.614	0.893	2.330	3.407	4.596	5.973	7.019
273	8	0.58	0.0	0.021	0.063	0.258	0.322	0.452	0.517	1.656	3.068	4.055	5.204	6.619
274	8	0.67	0.0	0.129	0.213	0.254	0.407	0.492	0.622	1.464	2.434	3.108	3.833	4.557
275	8	0.97	0.0	0.038	0.123	0.186	0.293	0.360	0.466	1.374	2.760	3.699	4.572	5.611
MEAN		0.75	0.0	0.061	0.131	0.221	0.345	0.479	0.624	1.706	2.917	3.865	4.895	5.951
STD. DEV.		0.2	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.4	0.4	0.6	0.9	1.1

Appendix B Hydrocarbon Loss Data for 6 Test Vehicles

Hydrocarbon Loss, grams, at each of the Following Times.

Vehicle	Test No.	1 Min.	10 Min.	20 Min.	30 Min.	40 Min.	50 Min.	59 Min.	60 Min.
Vega	021	.0141	.25	.51	.74	.93	1.07	1.17	1.18
	022	.0138	.22	.46	.67	.83	.95	1.05	1.07
	023	.0139	.13	.36	.53	.68	.80	.88	.89
	Mean	.0139	.20	.44	.65	.81	.94	1.03	1.05
	Std. Dev.	.0002	.06	.08	.11	.13	.14	.15	.15
Camaro	014	.0558	.38	.84	2.03	3.38	4.23	4.82	4.88
	016	.0633	.37	.99	2.01	3.41	4.46	5.09	5.15
	017	.0410	.39	.87	2.11	3.52	4.55	5.22	5.28
	Mean	.0534	.38	.90	2.05	3.44	4.41	5.05	5.10
	Std. Dev.	.0113	.01	.08	.05	.07	.16	0.20	.20
Matador	024	.0638	.67	1.91	6.06	9.75	12.31	13.99	14.14
	025	.0572	.57	1.56	5.07	9.10	12.43	14.16	14.31
	026	.1427	.83	2.54	6.78	11.40	15.11	17.45	17.64
	Mean	.0879	.69	2.00	5.97	10.08	13.3	15.20	15.36
	Std. Dev.	.0476	.13	.50	.86	1.19	1.58	1.95	1.97
Beetle	094	.0365	.46	.98	1.53	1.95	2.26	2.55	2.58
	097	.0364	.41	.98	1.12	1.91	2.21	2.46	2.49
	101	.0362	.41	.93	1.43	1.83	2.08	2.34	2.37
	Mean	.0621	.43	.95	1.36	1.90	2.18	2.45	2.48
	Std. Dev.	.0413	.03	.03	.21	.06	.09	.11	.11

Hydrocarbon Loss, grams, at each of the Following Times

Vehicle	Test No.	1 Min.	10 Min.	20 Min.	30 Min.	40 Min.	50 Min.	59 Min.	60 Min.
New Yorker	030	.0426	.43	.74	1.25	2.40	4.35	6.07	6.25
	032	.0353	.42	.91	1.33	2.81	5.15	7.05	7.26
	034	.0481	.55	1.09	1.87	4.54	7.53	10.12	10.33
	036	.0478	.45	1.10	2.26	4.86	7.52	8.91	9.09
	Mean	.043	.46	.96	1.68	3.65	6.14	8.03	8.23
	Std. Dev.	.006	.06	.17	.48	1.23	1.64	1.82	1.83
F-100	263	.064	.41	1.78	2.98	3.79	4.84	6.07	6.24
	264	.086	.58	1.71	2.97	3.89	4.99	6.37	6.52
	265	.017	.45	1.92	3.70	5.22	6.52	7.92	8.09
	266	.042	.48	1.81	3.28	4.43	5.64	6.98	7.13
	Mean	.052	.48	1.81	3.23	4.33	5.50	6.84	7.00
	Std. Dev.	.030	.07	.09	.34	.66	.76	.82	.76