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HS-803 668

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AMBIENT TEMPERATURE, FUEL ECONOMY,  
EMISSIONS, AND TRIP LENGTH

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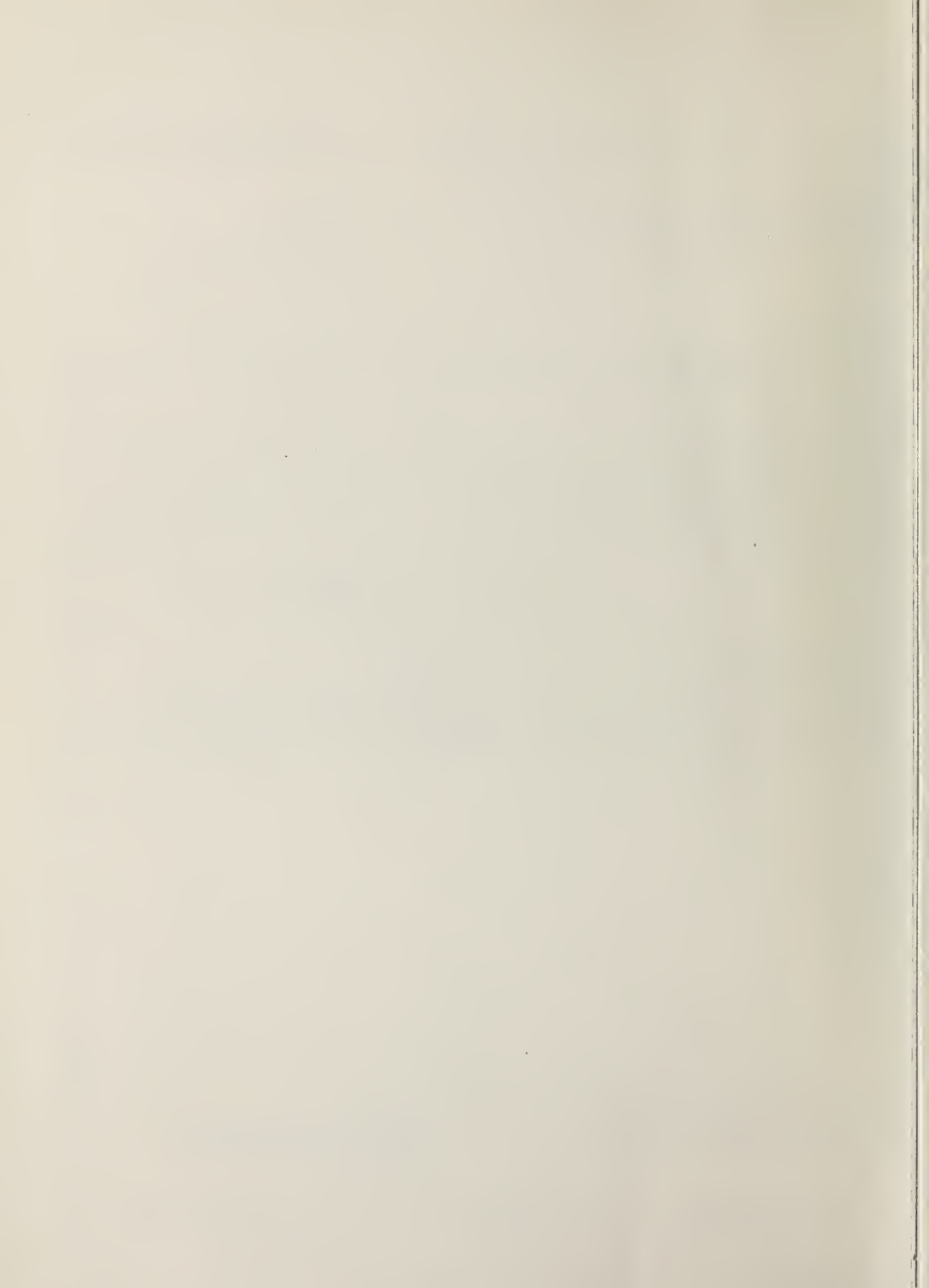
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16. Abstract This report examines the relationship among automotive fuel economy, ambient temperature, cold-start trip length, and drive-train component temperatures of four 1977 vehicles. Fuel economy, exhaust emission, and drive-train temperatures were measured at temperatures of 20° F, 45° F, 70° F, and 100° F using the 1975 Federal Test Procedure (75 FTP) and the EPA highway fuel economy test (HWFET).					
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## PREFACE

This report describes experimental work and findings in a study of the relationship among automotive fuel economy, ambient temperature, cold-start trip length, and drive-train component temperatures of four 1977 vehicles. Fuel economy, exhaust emissions, and drive-train temperatures were measured at temperatures of 20°, 45°, 70°, and 100° F using the 1975 Federal test procedure and the Environmental Protection Agency's highway fuel economy test.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
<b>AREA</b>				
in <sup>2</sup>	square inches	6.5	square centimeters	cm <sup>2</sup>
ft <sup>2</sup>	square feet	0.09	square meters	m <sup>2</sup>
yd <sup>2</sup>	square yards	0.8	square meters	m <sup>2</sup>
mi <sup>2</sup>	square miles	2.6	square kilometers	km <sup>2</sup>
	acres	0.4	hectares	ha
<b>MASS (weight)</b>				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
<b>VOLUME</b>				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft <sup>3</sup>	cubic feet	0.03	cubic meters	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.76	cubic meters	m <sup>3</sup>

**TEMPERATURE (exact)**

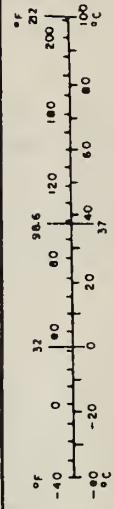
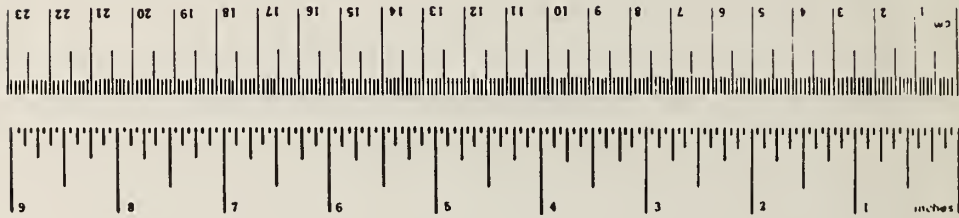
Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature
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Approximate Conversions from Metric Measures

When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>			
millimeters	0.04	inches	in
centimeters	0.4	inches	in
meters	3.3	feet	ft
kilometers	1.1	yards	yd
	0.6	miles	mi
<b>AREA</b>			
square centimeters	0.16	square inches	in <sup>2</sup>
square meters	1.2	square yards	yd <sup>2</sup>
square kilometers	0.4	square miles	mi <sup>2</sup>
hectares (10,000 m <sup>2</sup> )	2.5	acres	
<b>MASS (weight)</b>			
grams	0.026	ounces	oz
kilograms	2.2	pounds	lb
tonnes (1000 kg)	1.1	short tons	
<b>VOLUME</b>			
milliliters	0.03	fluid ounces	fl oz
liters	2.1	pints	pt
liters	1.06	quarts	qt
liters	0.26	gallons	gal
cubic meters	35	cubic feet	ft <sup>3</sup>
cubic meters	1.3	cubic yards	yd <sup>3</sup>

**TEMPERATURE (exact)**

Celsius temperature	9/5 (then add 32)	Fahrenheit temperature
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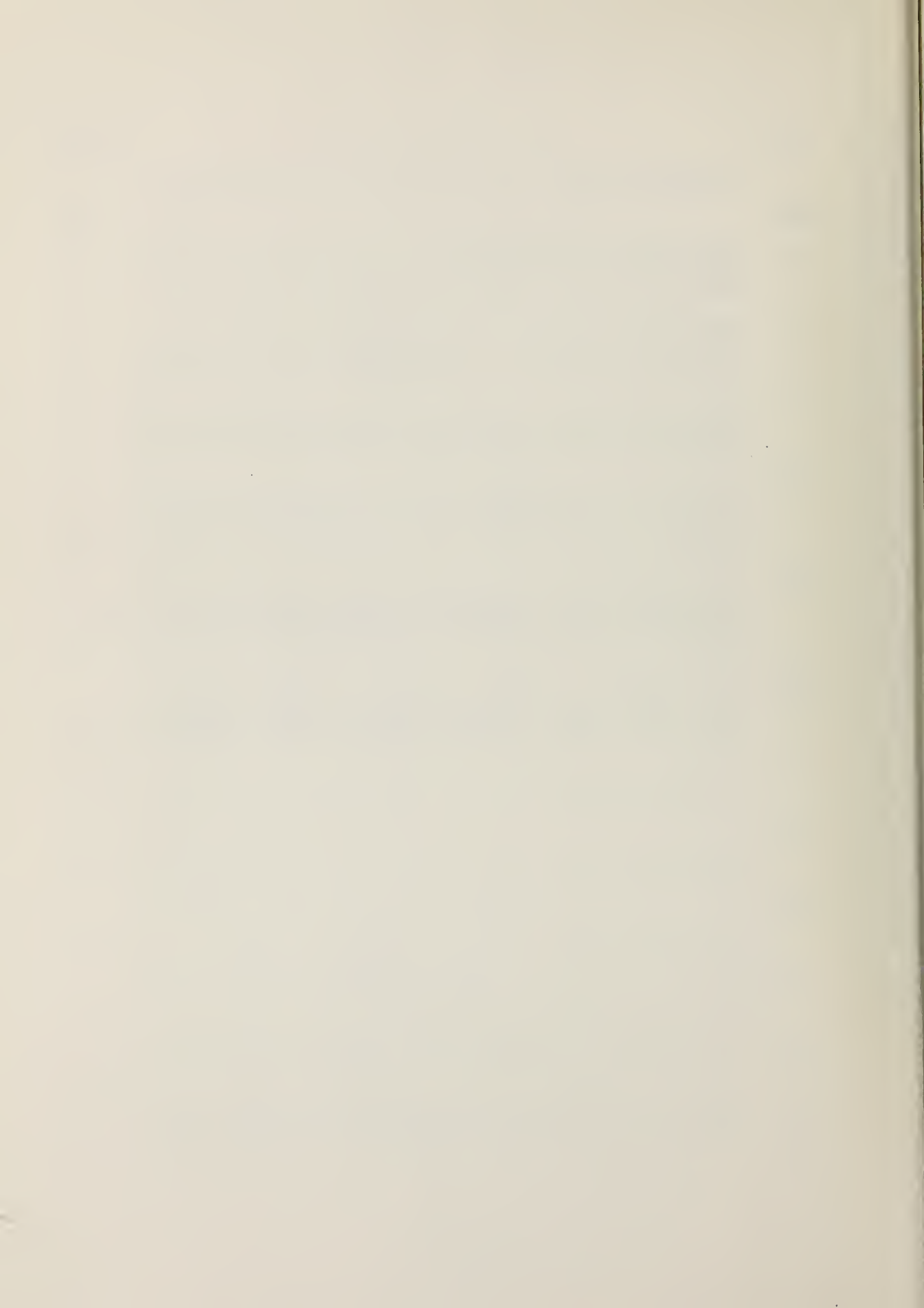
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## 1. INTRODUCTION

Most prior investigations of the influence of ambient temperature on fuel economy and/or exhaust emissions have been concerned with road evaluations and emissions of warmed-up vehicles. This study's primary concern is cold-start fuel economy using dynamometer cycles of the Federal test procedure (75 FTP) and temperatures from 20° F to 100° F. The mandated emissions and fuel economy goals tend to result in motor vehicles designed and tuned to an optimum combination of fuel economy and emission levels when operated over the specified federal driving cycles and within a temperature range of 68° to 86° F. However, automobiles are operated at temperatures well outside this range and a knowledge of fuel consumption and emission characteristics at other ambients is a continuing need. This study investigates the effect of ambient temperatures on exhaust emissions and fuel economy of four late-model vehicles. It also investigates the effect of trip length at various ambient temperatures but with the duty test cycle limited to the specific driving modes and distances specified by the federal procedure.

## 2. EXPERIMENTAL PROCEDURES

Four 1977 vehicles were operated through the federal test cycle at temperatures of 20°, 45°, 70°, and 100° F. Emissions and fuel economy were determined on a continuous basis as well as the conventional "bag analysis" method. The temperature profile of key engine and drive-train components was determined from thermocouple output during the test procedure. Additional data were gathered at steady-state engine operation.

### 2.1 Vehicles

The four 1977 vehicles were chosen from the classification sub-compact, compact, intermediate, and full-size. They were Ford 140-CID, four-cylinder Pinto; Chevrolet 250-CID, six-cylinder Nova Concours; General Motors 350-CID, eight-cylinder Cutlass; and Chrysler Corp. Plymouth 400-CID Gran Fury. A full description of the vehicles is in appendix A, table A-1. All were low mileage leased vehicles. They were tuned to the manufacturer's specifications, and 4,000 miles of city/highway road mileage were accumulated. Emissions of carbon monoxide (CO), hydrocarbon (HC), and oxides of nitrogen (NO<sub>x</sub>) were determined, and idle mixture adjustments were required on two of the vehicles to bring CO within specification. No further adjustments were made during the test period.

### 2.2 Fuels

Fuels were selected to minimize the risk of an interaction of volatility and temperature with fuel consumption. A fuel with 8.6 psi RVP and a 10 pct distillation temperature of 134° F was used at 45°, 70°, and 100° F ambients. A fuel with 12.9 psi RVP and a 10 pct distillation temperature of 108° F was used at 20° F ambient. Fuel properties are listed in appendix A, table A-2.

## 2.3 Driving Cycle

A combination of the Environmental Protection Agency's (EPA) 1975 FTP and the highway fuel economy test (HWFET) driving cycles was used. This selection was made so that standard FTP and HWFET fuel economy data could be one part of the temperature, emissions, and fuel economy results. The cycle as used consisted of the following phases: 1975 FTP cold transient (CT), stabilized (S), hot transient (HT), highway fuel economy warmup (HWFE No. 1), and the highway fuel economy test (HWFE No. 2). Included was a 10-minute soak between S and HT, 7 minutes of engine idle between HT and HWFE No. 1, and 3 minutes of engine idle between HWFE No. 1 and 2. These periods of engine idle were necessary to accommodate the available computer software and an established requirement to obtain both continuous exhaust analysis and bag sample analysis. No emissions or temperature measurements were made during these idle periods. The continuous analysis served as a quality control and permitted the calculation of fuel economy at selected time intervals during the driving cycle. A description of the test cycle with times and distances is listed in table 1.

## 2.4 Instruments and Apparatus

The chassis dynamometer was a Clayton ECE-50-120 with direct-drive inertia system and road load power control. Carbon monoxide, carbon dioxide (CO<sub>2</sub>), HC, and NO<sub>x</sub> analytical instruments were conventional with computer data acquisition and software for continuous analysis and fuel consumption calculations. The test cell temperature was controlled at 20°, 45°, 70°, and 100° F. However, the 20° F could not be maintained throughout the 77-minute test so the starting temperature was reduced to approximately 10° F resulting in approximately 20° F average for the test. The average conditions of temperature, humidity, and barometric pressure are listed in table 2.

## 3. RESULTS AND DISCUSSION

The basic data obtained in this project are: fuel consumption and emissions (appendix B); fuel consumption, emissions, and trip distance (appendix C); fuel consumption at 1-mile intervals of the FTP (appendix D); engine and drive-train temperatures (appendix E); steady-state temperatures, torque, and fuel consumption (appendix F). Examination of the individual vehicle data showed that the trends in fuel consumptions and emissions with trip length for four vehicles to be comparable. Therefore, the results from the four vehicles are averaged for purposes of discussions to follow.

### 3.1 Trip Length and Fuel Consumption

It is apparent from the data in table 3 that cold-start trip length exerts a great influence on fuel consumption.

The shorter the trip the lower the fuel economy in mpg. This results mainly from fuel-air mixture enrichment and lower drive-train efficiency during engine and drive-train warm-up period. An additional factor affecting fuel economy and emissions is the vehicle duty cycle or driving pattern. The mildest dynamometer duty cycle, in terms of fuel economy, would be start and acceleration to a defined speed followed by cruise at constant load. A much more severe duty cycle is the federal test procedure for emissions tests as

was used for part of the driving cycle in this project. The driving schedule chosen for this work, the rather severe FTP followed by the less severe highway fuel economy schedule, may represent an appreciable portion of vehicle miles traveled. The very short trips being almost all city with frequent stops, and trips of 11 miles or more involving urban highways that can be represented by the HWFET. The foregoing is intended to call the readers' attention to the variables to be considered in applying the test results. Figure 1 shows the complete time/speed profile for the cycle used. Figure 2 shows a difference in fuel economy with distance for the two types of cycles. It is apparent that the cruise cycle at 60 mph is less severe than the test cycle. The temperature data in appendices E and F also show a slower rate of warmup for the constant speed tests.

Analyses of the data show a solid relationship of fuel economy to trip length. Data at the four ambient temperature conditions are given in figure 3 and table 3. These data show that for the average of the four cars the fuel economy in miles per gallon at 70° F is 35 pct greater over a distance of 32 miles compared to the fuel economy attained over a shorter 3.6-mile trip. At 20° F ambient, the mpg value is 67 pct greater for the longer trip. Another useful comparison is also provided by the data of table 3 where values are shown for the fuel economy at varied trip lengths and the EPA highway fuel economy value. At the 20° F test temperature, 100 miles of driving composed of cold-start short trips of 3.6 miles (10.1 g/100mi) would require twice the fuel that 100 miles composed of warmed-up highway driving (4.9 g/100mi). At 100° F the fuel requirement is still 1½ times the highway rate. The data of table 3 for 100° F ambient represents, in addition to the temperature effect, the additional fuel required for operation of the vehicle's air conditioner. This information was obtained to provide information on the combined effect of temperature and air conditioner operation.

### 3.2 Rate of Warmup for FTP Cycles

Cumulative fuel economy at one-mile intervals of the FTP was obtained from the continuous analysis data as shown in table 4 and figure 4. Appendix D provides the individual vehicle data of the four car average. As shown in figure 4, fuel consumption is influenced by distance traveled and is strongly influenced by the driving modes as indicated by the slope changes of the curve. The data (figure 4) for the 100° F ambient with the air conditioner on shows the overriding effect of the air conditioner load.

### 3.3 Ambient Temperature and Fuel Consumption

Findings in the study provide information regarding the temperature effect on fuel requirement as well as the trip length effect. The effect of temperature can be shown in terms of the familiar FTP city and highway cycle fuel measurements. Table 5 is a listing of the four car average fuel economy data calculated according to the EPA fuel economy procedures for city, city-highway, and highway. The data for the 70° F fuel consumption and that at other test temperatures is shown in table 5. The greatest temperature effect, a 15 pct (1.03 g/100 mi) increase, occurs at 20° F ambient, and 7 pct (0.45 g/100 mi) increase occurs at 45° F ambient. In the highway cycle the increase in fuel use from 70° to 20° F ambient is only 2 to 3 pct. The change in fuel consumption resulting from cold start operation at 100° F combined with an added fuel



requirement for air conditioner operation can be obtained from the data. Comparison of fuel consumption at 70° F without the air conditioner in operation to that at 100° F with the air conditioner on shows a 13 to 14 pct increase in fuel required at the 100° F temperature. This fuel requirement increase results from the combination air conditioner load and the 30° F temperature increase.

### 3.4 Vehicle Temperatures

The following temperatures were recorded: Air-to-the-vehicle, air-to-the-carburetor, engine oil, coolant, transmission fluid, and differential lubricant. Thirty readings were taken during the elapsed 77 minutes; no readings were tabulated for the soak and idle periods. Appendix E provides temperature, time, and distance for all tests. Figure 5 shows the temperature warm-up profiles for one vehicle; figures for the other three are in appendix E. The temperature upset brought about by the soak and idle periods is apparent. The 10-minute soak causes the greatest disturbance. Of the temperature monitored, the coolant most rapidly approaches an equilibrium value, and the drive-train differential approaches most slowly. For the 20° to 70° F ambient range transmission and differential temperatures were affected to the greatest degree by a change in test temperature. The maximum temperature reached during the test cycle, averaged for the four vehicles, showed a rate of change with ambient of 0.7, 0.5, 0.3, and 0.2° F per °F ambient for the transmission, differential, oil, and coolant. The four car average maximum test cycle temperature at the 70° F test was: transmission--188° F, differential--159° F, oil--214° F, and coolant--203° F.

Although the test cell is designed to provide conditioned air flow at vehicle speed across the vehicle, radiant heat loads and relative road-surface-vehicle effects are not simulated. Therefore, it is not known how well the temperatures will correlate with road test values. However, the general shape and character of the curves are expected to bear a reasonable correlation with road temperatures.

### 3.5 Steady-State Operation

Measurements from a cold start, with rapid acceleration to a constant speed were used to demonstrate a relationship of ambient temperature to a rate of warm-up that was not affected by varying loads imposed by the changing modes of the test cycle. Two vehicles were operated on the dynamometer at speeds of 30, 40, and 60 mph at inertia and load as specified for the EPA-FTP. Test ambients were 20°, 45°, and 70° F with air conditioner off; and 100° F with air conditioner on. Temperatures, fuel economy, and drive shaft torque were measured. Data were obtained at one-minute intervals to 9 minutes, then at 3-minute intervals to 60 minutes. The data are presented in the 24 tables of appendix F. Figure 6 is a plot of data for vehicle 156 operated at 100° F ambient and 45 mph. The data are derived from the tables of appendix F. The unit on the ordinate "Short Trip Excess Fuel Requirement, percent"\* was chosen to emphasize the marked effect of cold start short trips on fuel economy. To obtain "percent excess fuel"\*, the cumulative fuel required for a trip of a given length was multiplied by the ratio of 32 miles to the trip length. This

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\*{[Fuel for trip (32/trip miles) - fuel for 32 miles] ÷ fuel for 32 miles} x 100.

was subtracted from the fuel requirement for the single 32-mile trip and the difference converted to a percentage. In figure 6 the total trip length was taken as 32 miles. Figure 7 is a similar plot showing a comparison of a constant 30 mph test and the test cycle of this report, both at 100° F ambient test temperature. The curve for the cycle operation reflects the increased fuel demand of the acceleration modes of the city driving cycle portion of the test. Figure 8 is a presentation of typical fuel economy versus distance with the fuel economy presented on a cumulative basis. The test data are in appendix F. The distance to reach a stable condition, as indicated by a constant slope implies, that somewhat greater than 30-45 miles travel at this light load is required; however, the rate of change is greatly reduced beyond about 20 miles.

The change in drive shaft torque with temperature and distance is illustrated for vehicle 158 in figures 9 and 10. The torque measured reflects the load applied by the dynamometer (which was held constant by load control), axle losses, tire friction, bearing friction, and other system frictional losses. At 100° F the ambient temperature effect is small, and the time to approach equilibrium is short. At 20° F, about 15 minutes of driving at 30 mph is required. For precise measurement and definition of temperature-distance effects on drive-train warmup, a much more sophisticated instrumentation than was available is required.

### 3.6 Temperatures in Steady-State Operation

Temperature data for the steady-state tests are found in appendix F. Figures 11 and 12 show data for the two extremes 30 mph 70° F ambient and 60 mph 100° F ambient. In figure 12, the coolant exhibits the highest warmup rate, and the differential lubricant exhibits the lowest. In figure 11, the transmission fluid exhibits the lowest rate.

## 4. EMISSIONS

A relationship between CO, HC, and NO<sub>x</sub> emissions; trip length; and ambient temperature is illustrated in figures 13 through 16. In these figures emission rates are expressed as a ratio of the rate over a given trip length to the rate obtained using the 1975 FTP. The average ratios so obtained are listed in table 6. The curves in figures 13 through 16 are drawn through the 5 points representing the cumulative mileage at the end of each of the five phases of the test cycle. The rates taken over smaller increments of distance deviate from the curves, depending upon the load and speed changes of the cycle (i.e., the fuel consumption rate as shown in figure 4).

The relative rate of CO emissions is sensitive to trip length and temperature. The 3.6 mile CO relative emission rate [ratio of CO emissions at test conditions to FTP CO emissions (table 6)] for the four-car average was 15.6 times the FTP value. The CO relative emission rate increased by a factor of approximately 5.4 as the test ambient temperature was decreased from 70° F to 20° F. The relative rate increased by a factor of about 7.4 as the trip distance is shortened from the 31.6 miles to 3.6 miles. The effect decreases as the trip length or temperature is increased.

The effect of trip length on HC emissions is similar to that for CO, but the temperature effect is about half.

By comparison, the NO<sub>x</sub> emissions are only slightly affected by the cold start trip length and the ambient temperature range covered. The temperature effect, in general, resulted in lower emission rates for the 70° F temperature, but the differences were small, and individual car trip lengths effects were not consistent.

## 5. SUMMARY OF CONCLUSIONS

### Fuel Economy

The four car averaged data show that at 20° F ambient the fuel economy for a 3.6-mile cold-start trip was only 47 pct of the warmed-up 70° highway fuel economy. The cold-start 31.6-mile trip at 20° F ambient shows fuel economy of 78 pct of the 70° highway fuel economy. Cold-start trips at 70° F show respective values of 64 pct and 86 pct. Table 6 presents the data for all temperatures.

Short cold-start trips have a drastic influence on CO and HC emission rates, and this effect is greater with decreasing ambient temperature. The average data for four 1977 vehicles show CO emissions at 20° F ambient to be 15.6 times greater for the cold-start 3.6-mile trip than the emissions determined by the FTP. At 31.6 miles the rate is 2.1 times the FTP rate. At 70° F these respective factors are 2.9 and 0.5. Hydrocarbon emissions are influenced in a similar manner but with smaller temperature effect.

Oxides of nitrogen are only slightly affected by the change in temperature and trip length for the conditions of the study.

The effect of cold-start trip length on fuel economy was similar for the four tested vehicles. The four vehicle average relative fuel economy for the cycle data (column 2, table 6) and the individual vehicle mpg for the highway fuel economy (HWFE No. 2) from appendix B, tables 1 through 4, can be used to calculate the individual vehicle cumulative fuel economy for the five trip lengths. These when compared with the measured values of appendix C, tables 1 through 4, are in excellent agreement with a 95 pct confidence level of 0.3 mpg. This demonstrates the trip distance effect fuel economy for the four very different size vehicles to be very similar. Note that the above calculations would not necessarily apply to trip distance other than the five measured values.

Trip length/fuel economy data for the two duty cycles used in this work and published information\* indicate that the driving duty cycle has a marked effect on cold-start short trip fuel economy. Therefore, if estimates of fuel

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\*T.C. Austin and K.H. Hellman, "Passenger Car Fuel Economy as Influenced by Trip Length." Paper 750004 presented at SAE Automotive and Engineering Congress and Exposition, Detroit, MI, February 1975.

C. E. Scheffler and G. W. Niepoth, "Customer Fuel Economy Estimated from Engineering Tests." Paper 658061 presented at the SAE National Fuels and Lubricants Meeting, Tulsa, Oklahoma, November 1965.



usage and effects of vehicle changes on fuel economy are intended, driving patterns used to measure trip effects should cover a range of duty severity.

The engine oil, transmission fluid, and differential lubricant temperatures recorded during the test cycle showed an effect of ambient temperature in both rate of warm-up and maximum temperatures. The engine oil reached 95 pct of the maximum temperature in approximately 15 miles, the transmission in 16 miles, and the differential in 22 miles of cycle driving. The ambient temperature affected the rate of warm-up of the transmission fluid and differential more than it did engine oil.

In general, the data indicate that even after great improvements in carburetion over the past few years, current-production autos suffer as much in the ratio of cold start to warmed-up fuel economy and emissions penalty as was found with models dating back several years. It therefore appears that improvement of cold weather fuel economy and emissions still offers a good field for overall fuel economy improvement.

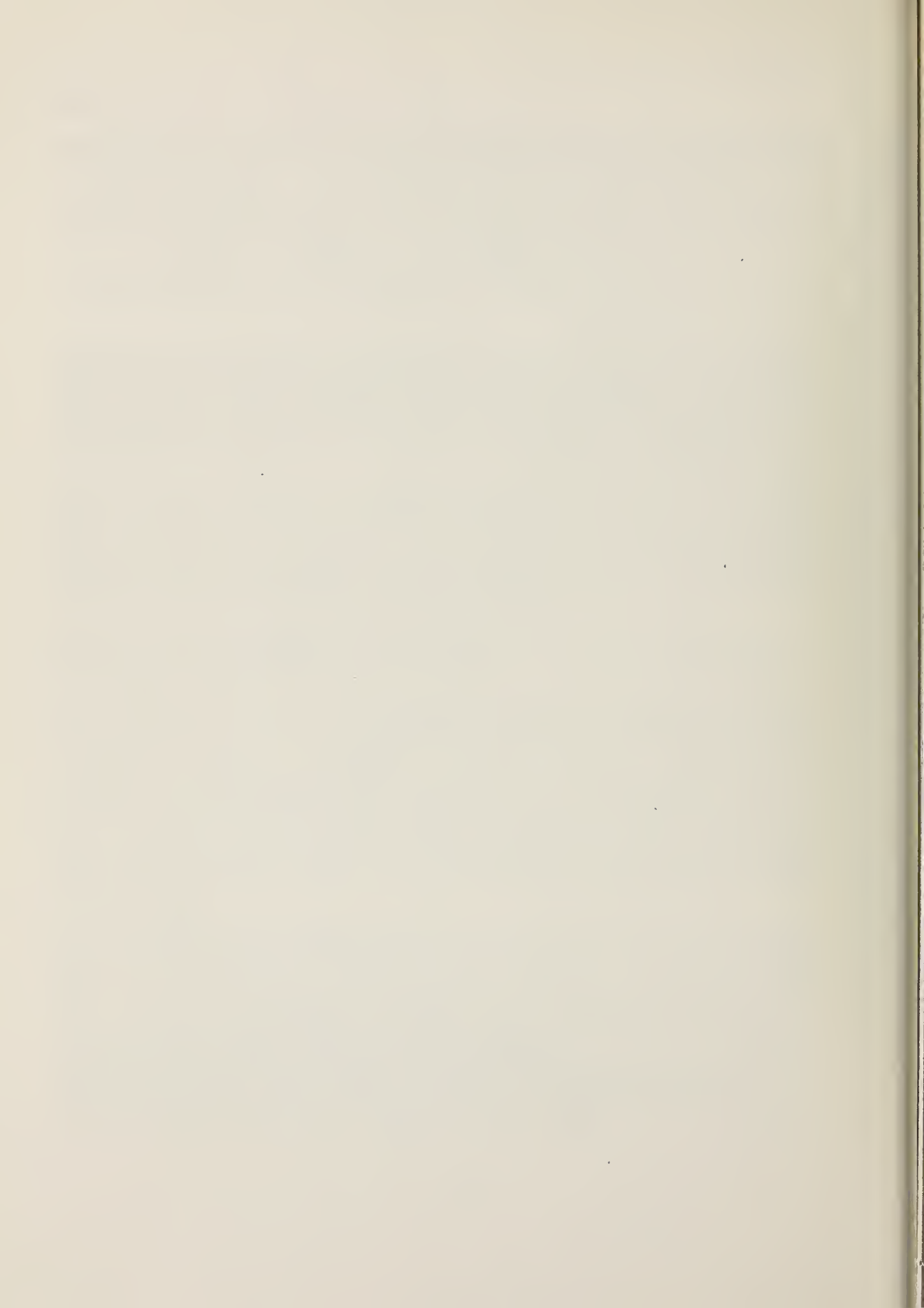


TABLE 1. - Modified 1975 FTP and HWFET driving schedule

Designation	Cumulative time, minutes	Cumulative distance, miles
Cold transient.....	8.4	3.6
Stabilized.....	22.9	7.5
Soak.....	32.9	7.5
Hot transient.....	41.3	11.0
Idle.....	48.3	11.0
Highway warmup (highway #1).....	61.0	21.3
Idle.....	64.0	21.3
Highway fuel economy (highway #2).....	76.8	31.6

NOTE. - No measurements were made during soak or idle periods.

TABLE 2. - Ambient test, barometer, and humidity conditions

Nominal test temp., °F	Average temperatures							Barometric pressure, mmHg		Moisture, grains/lb	
	Test phase				Highway			Avg.	Standard deviation	Avg.	Standard deviation
	Cold trans.	Stabilized	Hot trans.	Highway #1	Highway #2	Full test Avg.	Full test Standard deviation				
20.....	14	18	18	25	29	20.8	6.1	745	4	12	2
45.....	46	47	46	48	48	47.0	1.0	741	2	23	6
70.....	71	70	71	73	73	71.6	1.3	743	2	48	5
100.....	100	101	101	102	103	101.4	1.1	742	2	73	9

TABLE 3. - Trip length and fuel consumption

Trip, miles	Test temperature, °F			
	20	45	70	100 <sup>1</sup>
FUEL ECONOMY, MILES PER GALLON 4-VEHICLE AVERAGE				
0 - 3.6	9.9	11.8	13.5	12.5
0 - 7.5	11.5	13.0	14.2	12.7
0 - 11.1	12.4	13.6	14.6	13.0
0 - 21.3	15.1	16.2	17.0	15.1
0 - 31.6	16.5	17.4	18.2	16.1
FUEL CONSUMED, GALLONS/100 MILES				
0 - 3.6	10.10	8.47	7.41	8.00
0 - 7.5	8.70	7.69	7.04	7.87
0 - 11.1	8.06	7.35	6.80	7.68
0 - 21.3	6.62	6.21	5.88	6.67
0 - 31.6	6.06	5.75	5.49	6.21
HIGHWAY FUEL ECONOMY, GALLONS/100 MILES				
21.3 - 31.6	4.85	4.80	4.72	5.38

<sup>1</sup>100° F tests with air conditioner in operation.

TABLE 4. - Cumulative fuel economy at 1-mile intervals of the Federal test procedure--4-vehicle average

Distance, miles	Fuel economy, mpg			
	20°	45°	70°	100° <sup>1</sup>
0.9	6.0	8.1	10.5	11.1
1.79	7.8	9.6	12.2	12.6
2.69	9.4	11.3	13.4	12.6
3.59	10.0	11.9	13.5	12.4
4.53	10.3	11.9	13.4	12.4
5.54	11.2	12.9	14.2	12.9
6.53	11.6	13.2	14.4	12.8
7.50	11.6	13.1	14.2	12.5
8.44	11.7	13.1	14.2	12.5
9.24	12.0	13.3	14.4	12.7
10.14	12.4	13.7	14.7	12.9
11.04	12.5	13.7	14.7	12.9

<sup>1</sup>With air conditioner in operation.

TABLE 5. - Ambient temperature and fuel consumption, 4-vehicle average

Test cycle	Test temperature, °F			
	20	45	70	100 <sup>1</sup>
FTP FUEL ECONOMY, MILES PER GALLON				
City.....	12.9	13.9	14.8	13.1
City - highway...	15.5	16.3	17.1	15.1
Highway.....	20.6	20.9	21.2	18.6
FTP FUEL CONSUMPTION, GALLONS PER 100 MILES				
City.....	7.79	7.20	6.76	7.65
City - highway...	6.47	6.12	5.84	6.62
Highway.....	4.85	4.80	4.72	5.38
FTP FUEL CONSUMPTION, PCT INCREASE OVER 70° TEST				
City.....	15	7	0	13
City - highway...	11	5	0	13
Highway.....	3	2	0	14

<sup>1</sup>With air conditioner in operation.



TABLE 6. - Relative fuel economy and emissions

Trip miles	Relative fuel economy <sup>1</sup>				Cycle relative emissions <sup>2</sup>		
	Cycle	30 mph	45 mph	60 mph	CO	HC	NO <sub>x</sub>
20° F							
3.6	0.47	0.48	0.54	0.54	15.6	9.6	2.0
7.5	.54	.60	.66	.67	8.1	5.1	1.6
11.1	.59	.66	.71	.70	5.8	3.7	1.5
21.3	.71	.65	.80	.79	3.1	2.0	1.5
31.6	.78	.79	.84	.83	2.1	1.4	1.5
45° F							
3.6	.56	.61	.67	.71	8.5	4.9	1.8
7.5	.61	.73	.77	.80	4.5	2.8	1.3
11.1	.64	.78	.82	.84	3.2	2.1	1.3
21.3	.76	.85	.88	.90	1.7	1.2	1.3
31.6	.82	.88	.91	.93	1.2	.8	1.3
70° F							
3.6	.64	.73	.76	.72	2.9	2.4	1.3
7.5	.67	.82	.84	.81	1.7	1.5	1.0
11.1	.69	.87	.88	.85	1.3	1.2	1.1
21.3	.80	.92	.93	.91	.7	.7	1.2
31.6	.86	.95	.96	.94	.5	.5	1.2
100° F, w/a <sup>3</sup>							
3.6	.59	.62	.73	.67	2.1	2.1	1.7
7.5	.60	.72	.80	.73	1.7	1.6	1.5
11.1	.61	.77	.83	.76	1.7	1.5	1.6
21.3	.71	.82	.87	.80	1.0	.9	1.5
31.6	.76	.85	.89	.82	.8	.7	1.5

<sup>1</sup>Relative fuel economy = average fuel rate (mpg) to the end of a phase (miles) divided by average fuel economy for Federal highway fuel economy test at 70° F. For constant speed tests the fuel economy divided by the average for 21.3 to 31.6 mile increment.

<sup>2</sup>Relative emission rate = average emission rate from start of test to end of a phase (miles) divided by the emissions calculated for 1975 FTP (weighted at 70° F).

<sup>3</sup>With air conditioning.

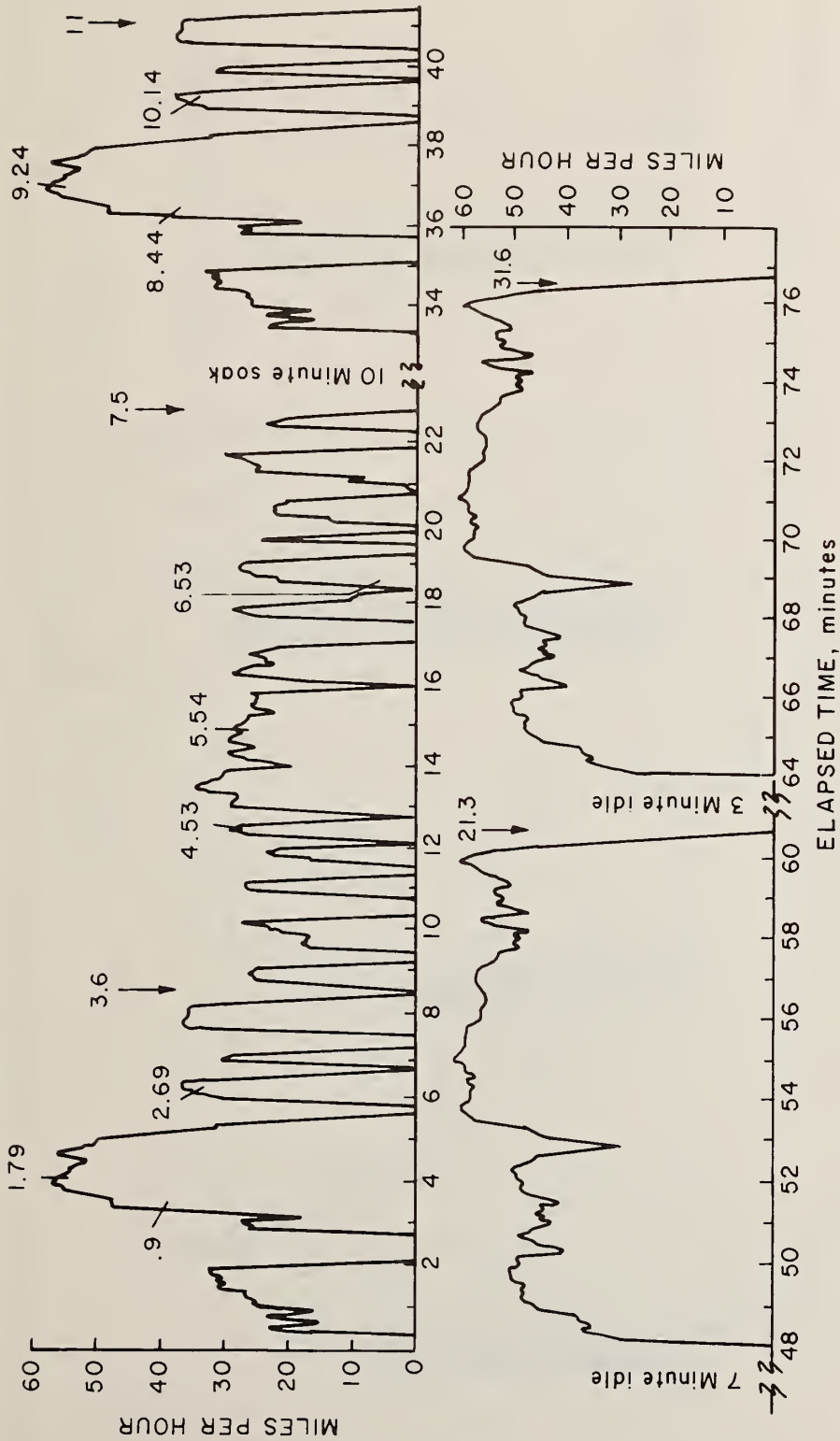


FIGURE 1. - Driving Schedule Used--Numerical Values with Arrows Toward x Axis Indicate Miles at End of a FTP Driving Phase--Other Index Markings on Curves Indicate Trip Distance Sampling Points of Appendix D.

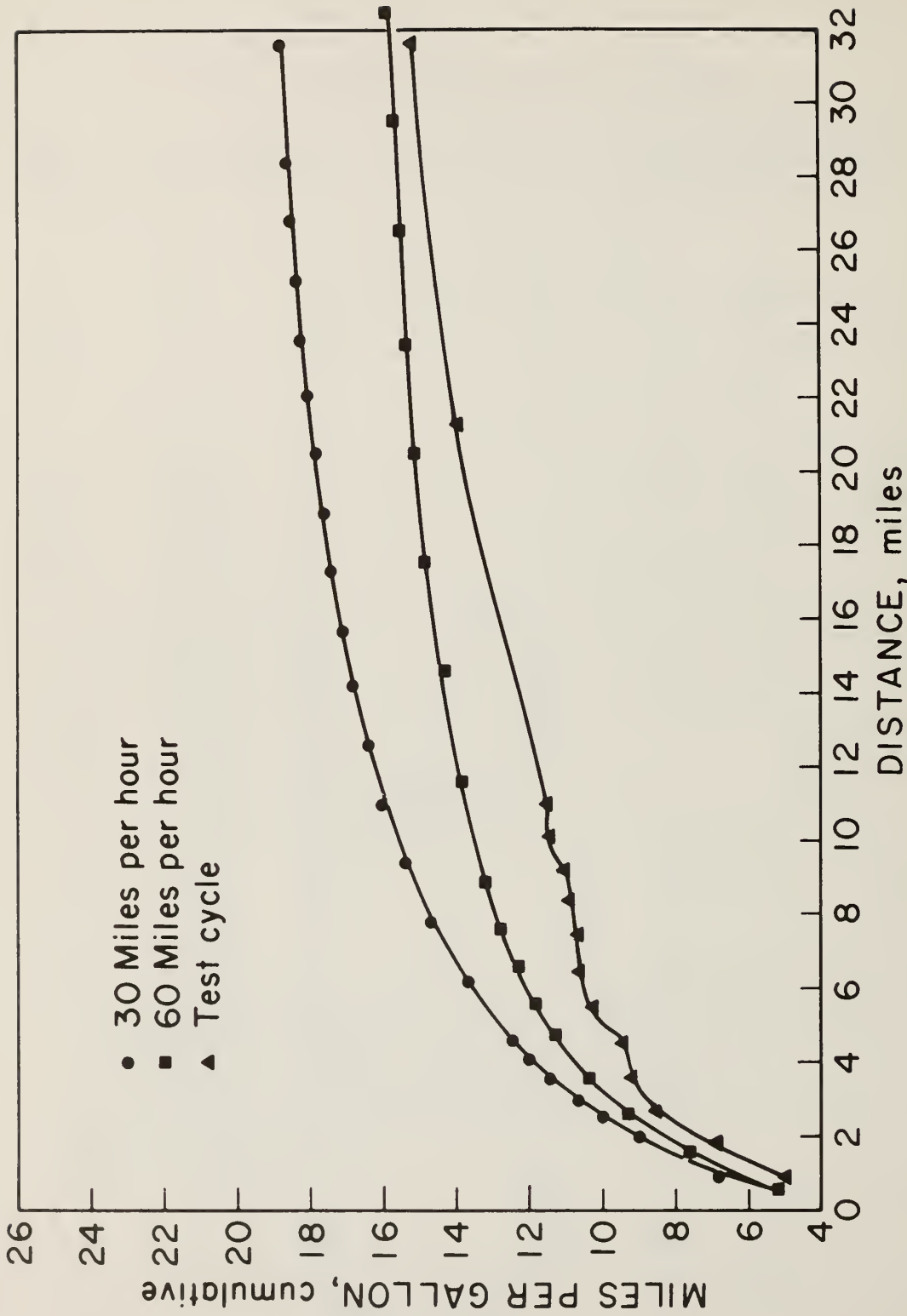


FIGURE 2. - Fuel Economy for the Test Cycle and 2 Constant Speed Tests, Both from Cold Start--Vehicle No. 158 at 20° F Ambient.

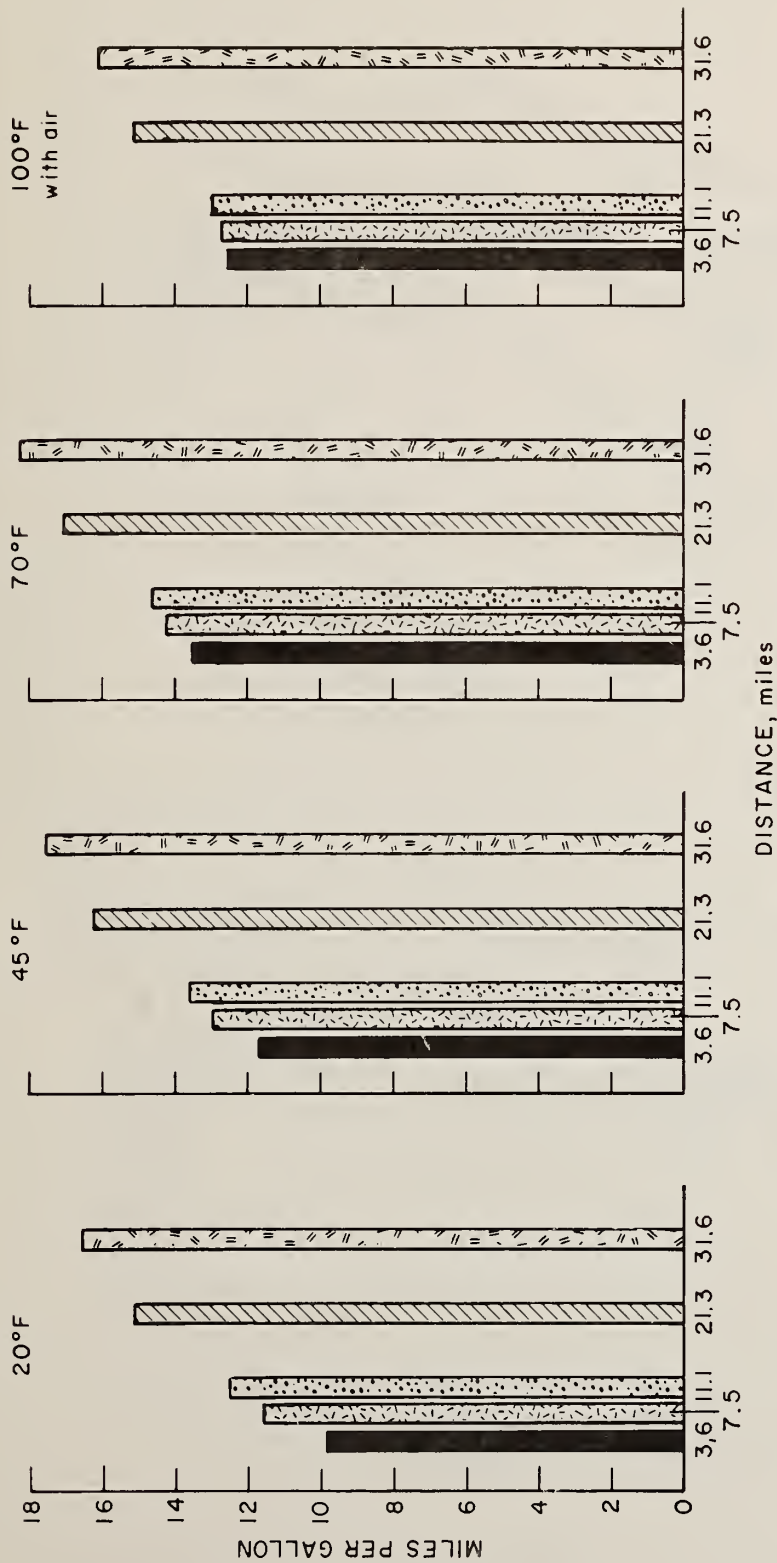


FIGURE 3. - Fuel Consumption Rate as Influenced by Trip Length, 4-Vehicle Average (100° F Ambient Data Taken with Air Conditioner in Operation).

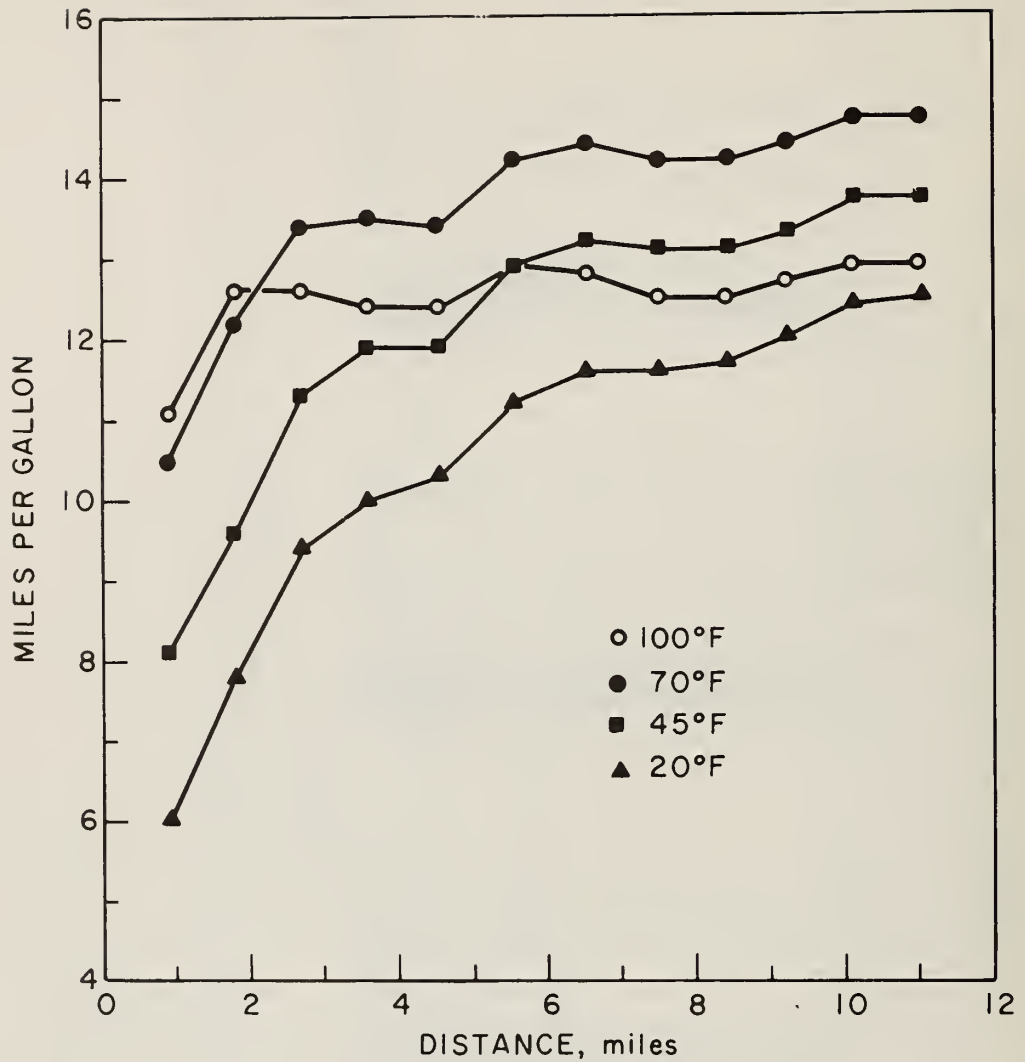


FIGURE 4. - Cumulative Fuel Economy at 1-Mile Intervals of the FTP (See Figure 1 for Driving Cycle).

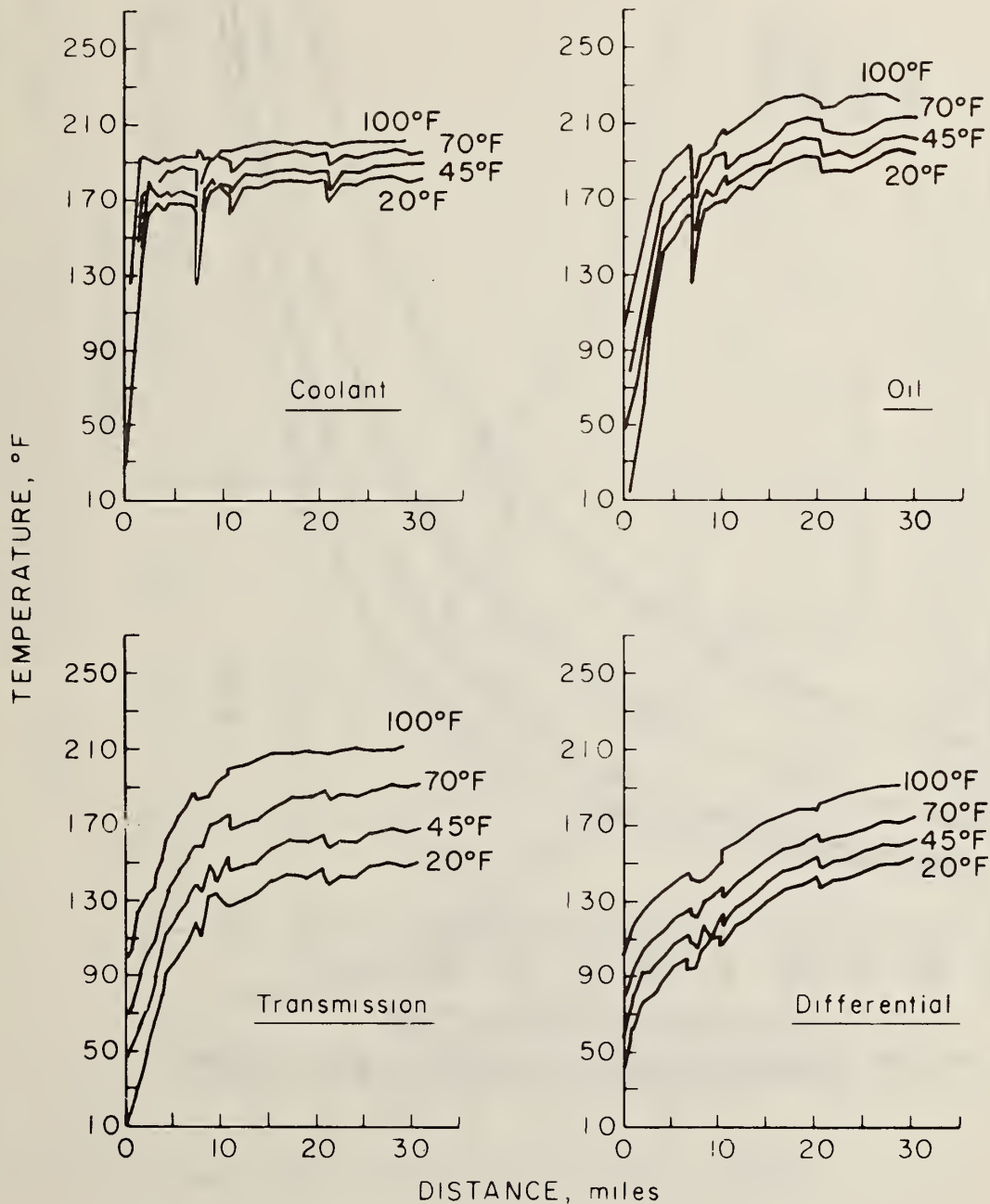


FIGURE 5. - Vehicle Temperatures and Distance Traveled During Cycle Operation from a Cold Start--Vehicle No. 156.

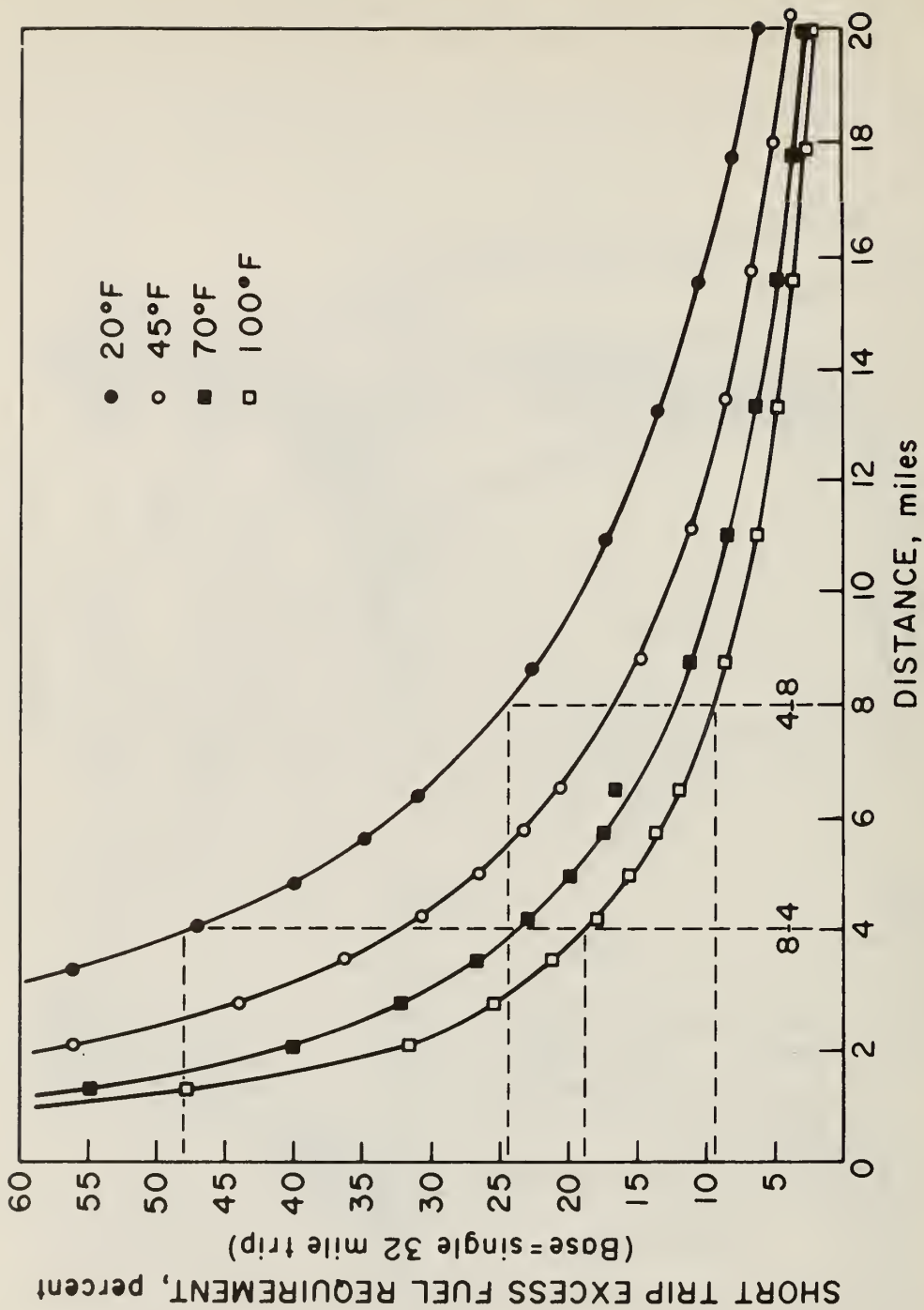


FIGURE 6. - Excess Fuel Required for Multiple Cold Start Trips  
 Equivalent to a Single 32-Mile Trip, Steady-State  
 Cruise of 45 mph--Vehicle No. 156.



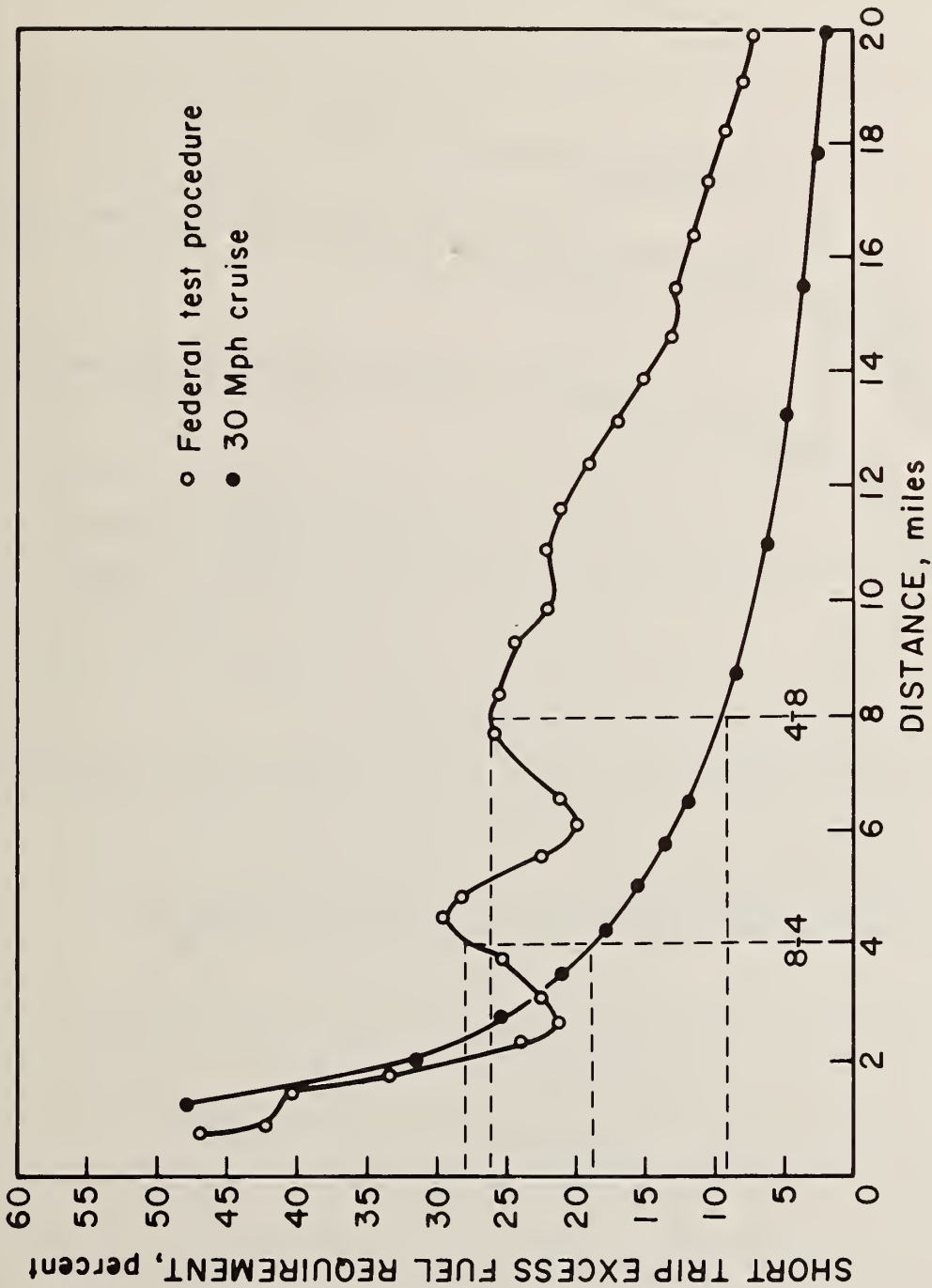


FIGURE 7. - Excess Fuel Required for Multiple Cold Start Short Trips Totaling 32 Miles Over that Required for a Single 30-Mile Trip--Vehicle No. 156 at 100° F Ambient (See Figure 1 for FTP Driving Cycle Used).

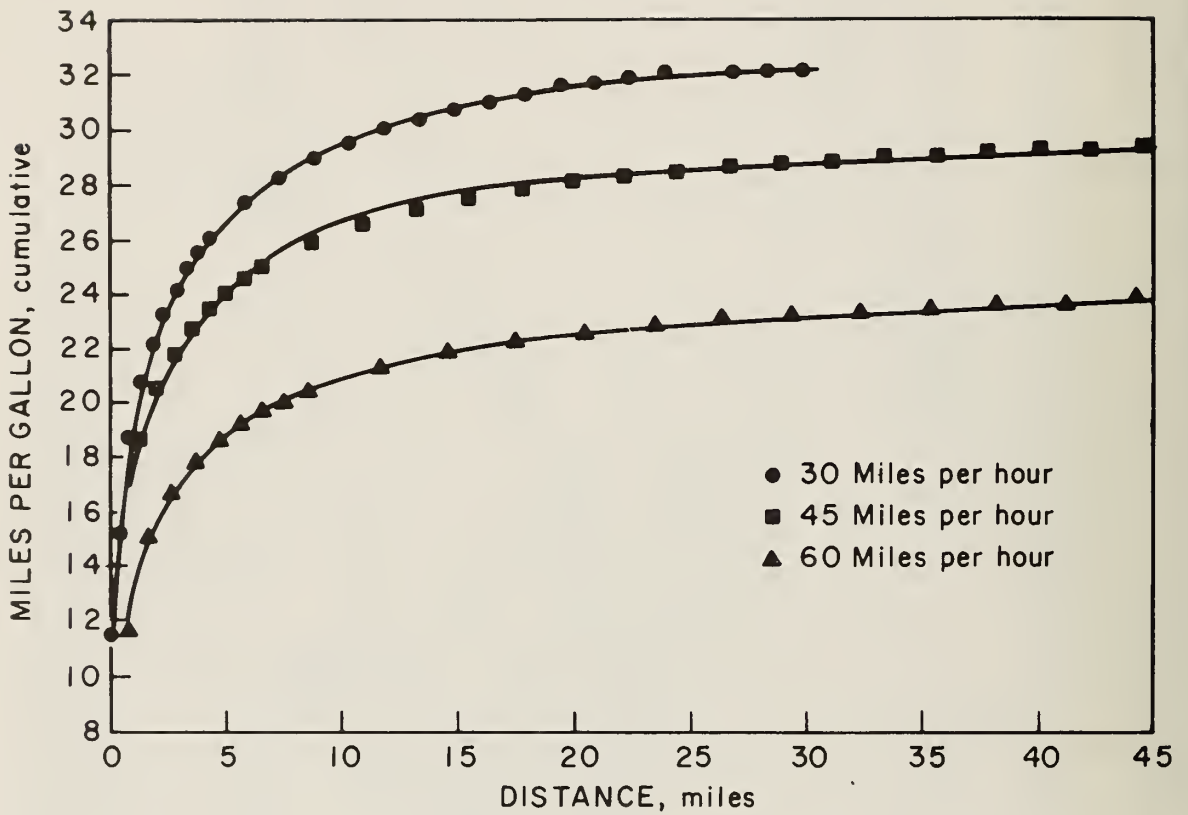


FIGURE 8. - Fuel Economy for Steady-State Operation from a Cold Start--Vehicle No. 156 at 70° F Ambient.

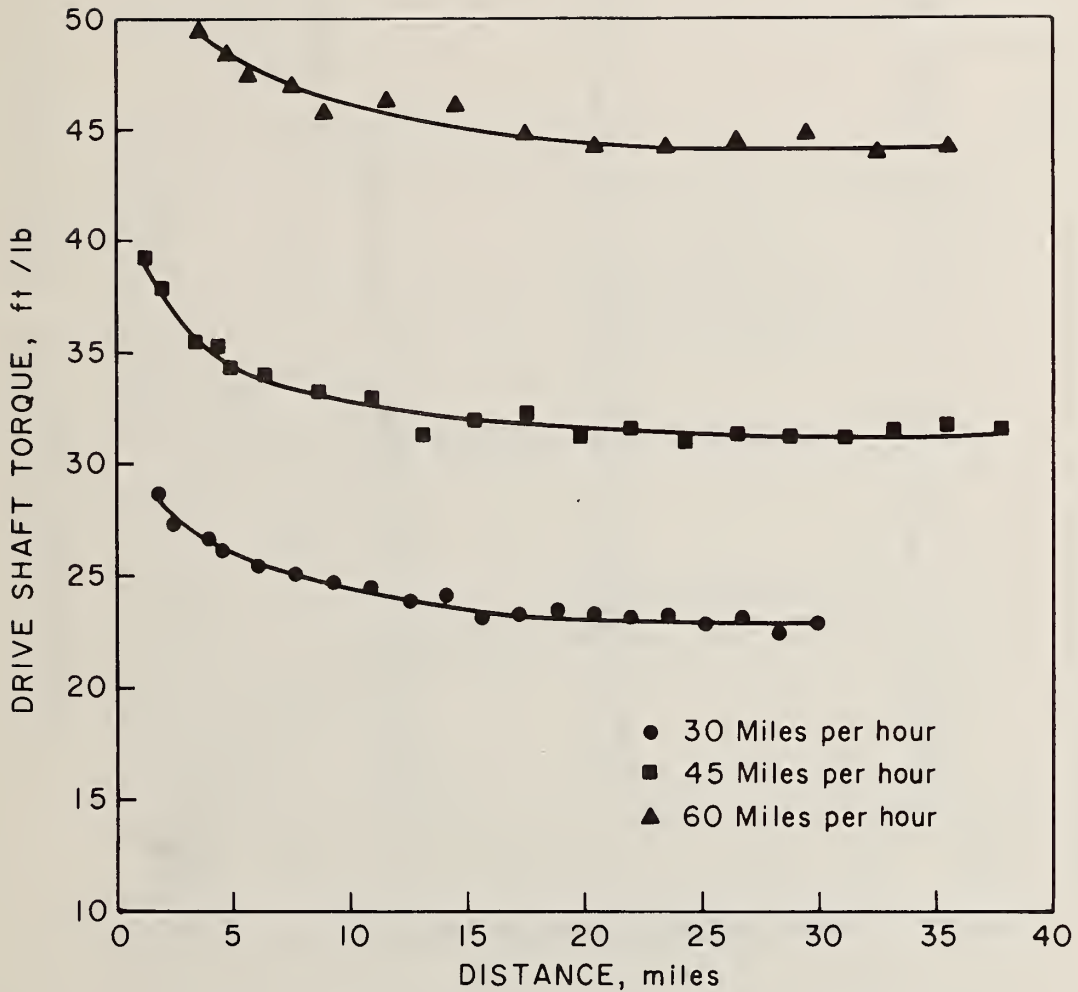


FIGURE 9. - Drive Shaft Torque, Steady Cruise Conditions, Cold Start--Vehicle No. 158 at 20° F Ambient.

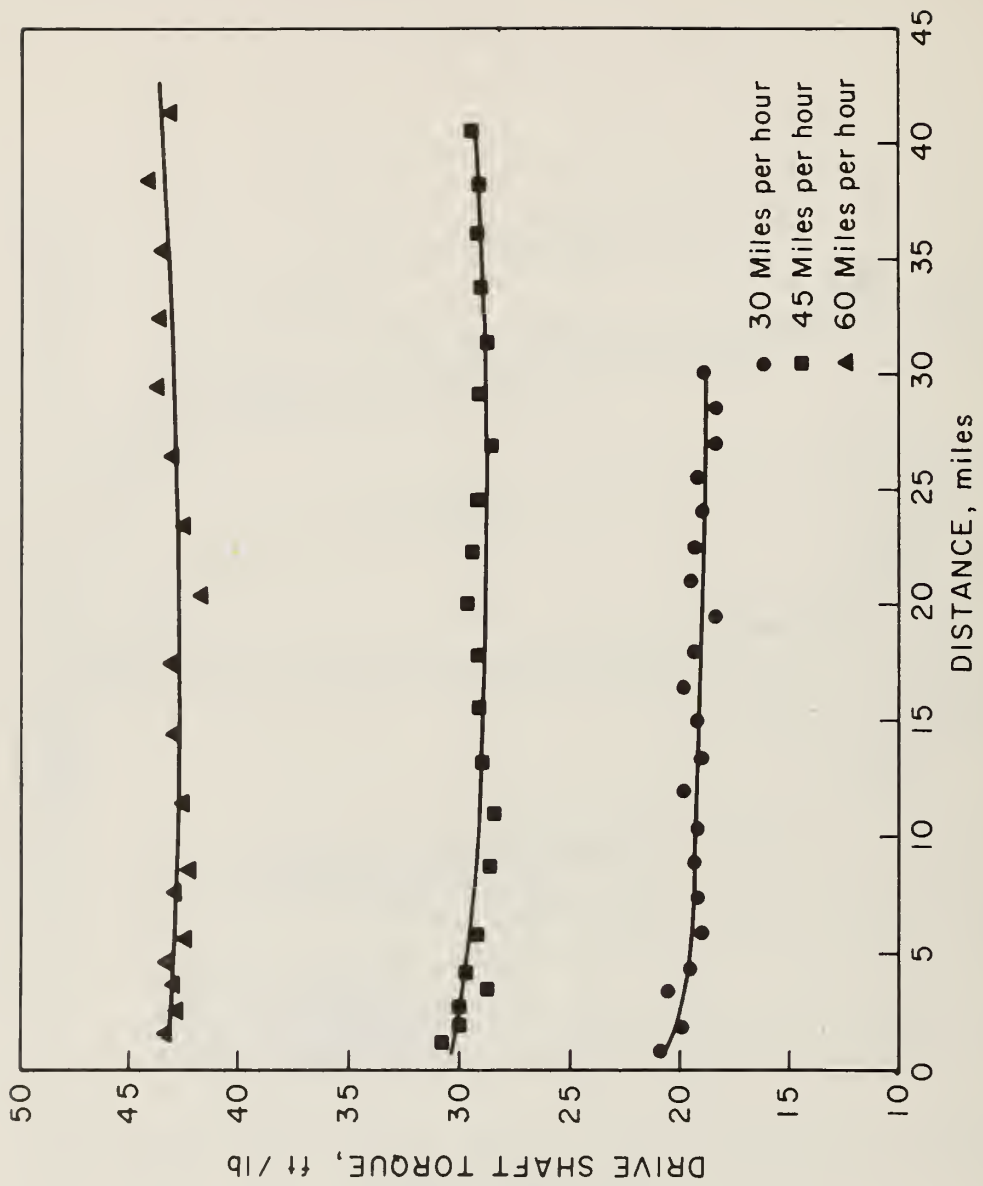


FIGURE 10. - Drive Shaft Torque, Steady Cruise Conditions, Cold Start--Vehicle No. 158 at 100° F Ambient.

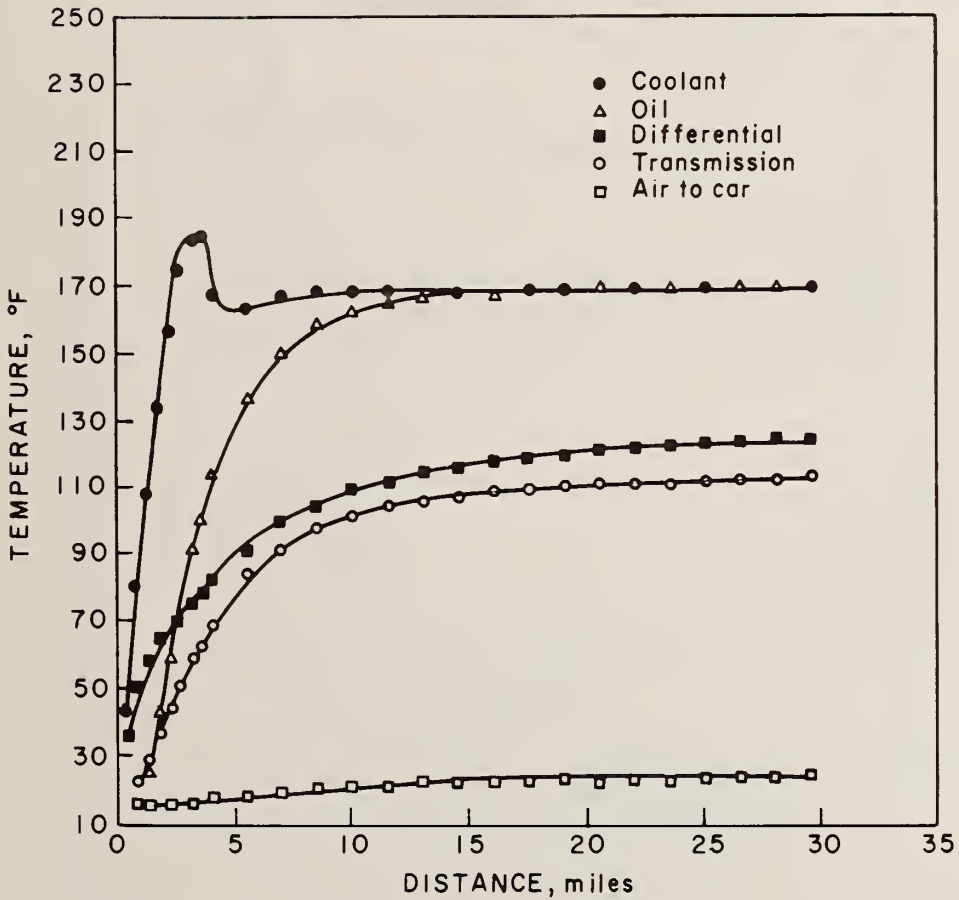


FIGURE 11. - Vehicle Component Warm-Up Rates--Vehicle No. 156 Started Cold at 20° F and Accelerated to a Constant Speed of 30 mph.

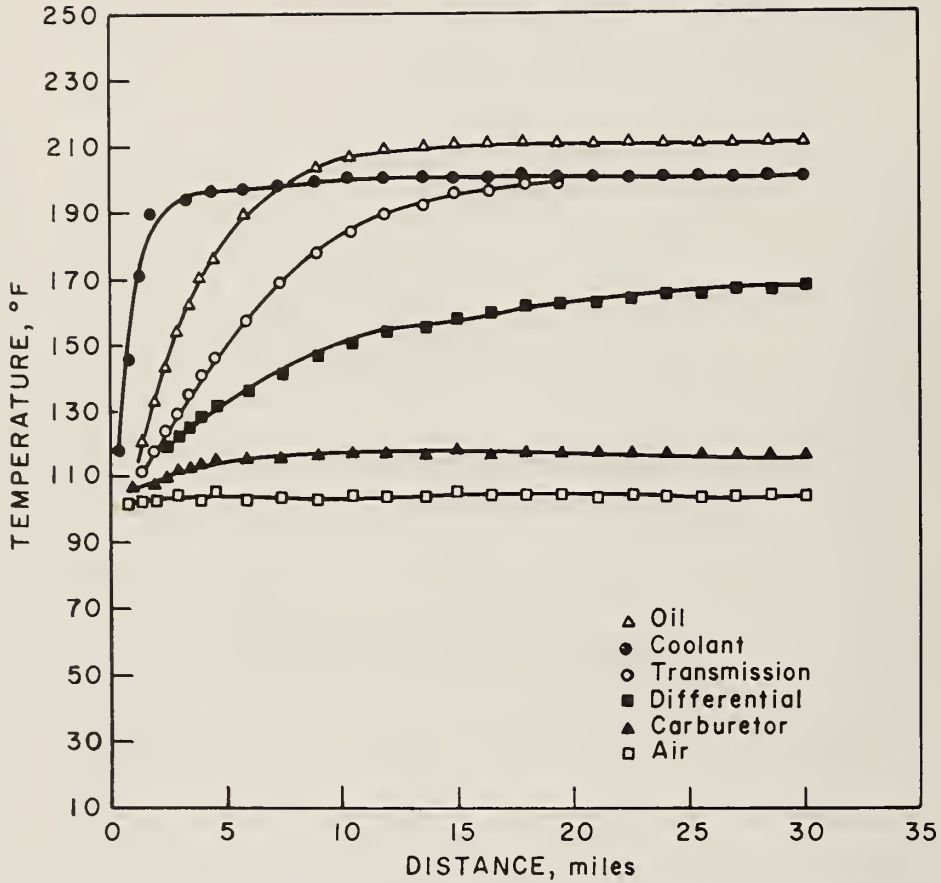


FIGURE 12. - Vehicle Component Warm-Up Rates--Vehicle No. 156 Started Cold at 100° F and Accelerated to a Constant Speed of 30 mph.



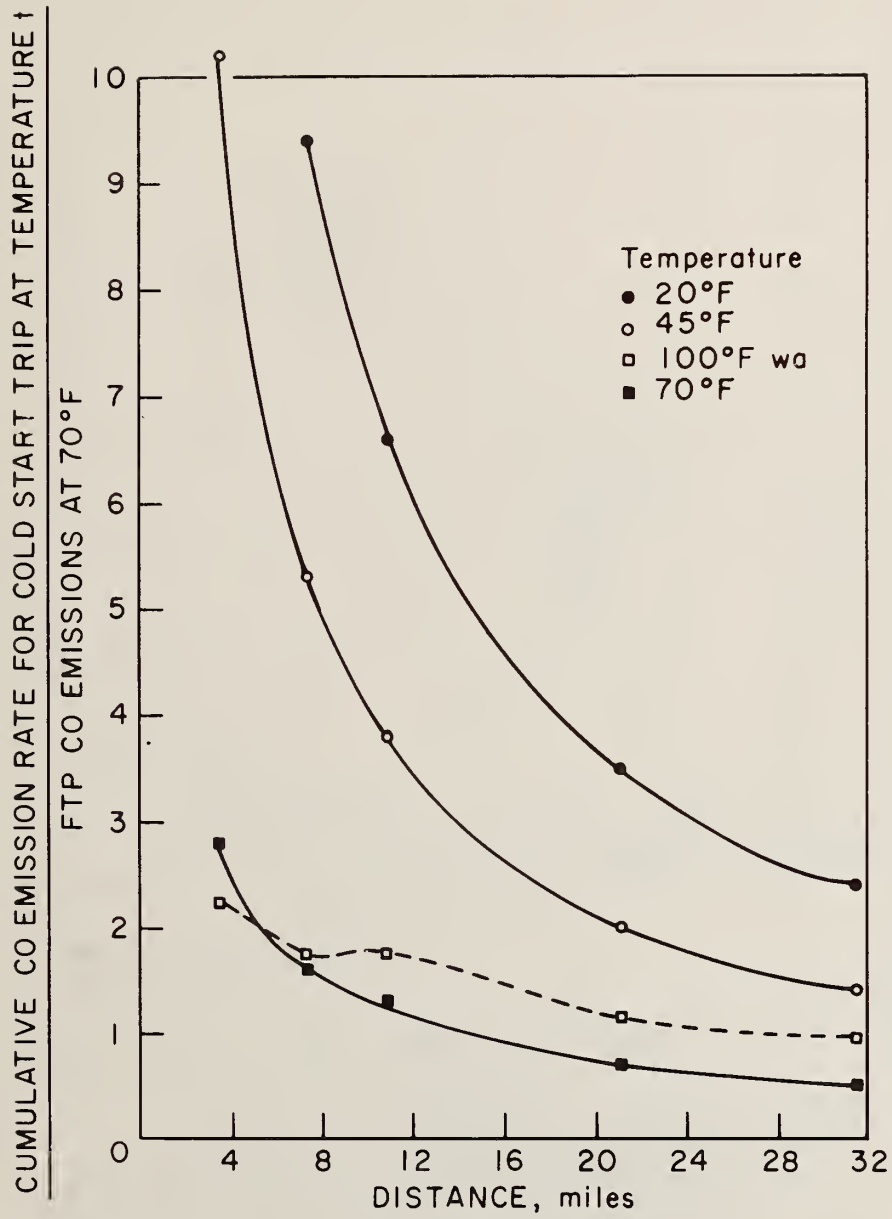


FIGURE 13. - Trip Length and Temperature Effect on Average Carbon Monoxide Emissions Rate Relative to Federal Test Procedure Emissions Rate--100° F Test Conducted with Air Conditioner in Operation.

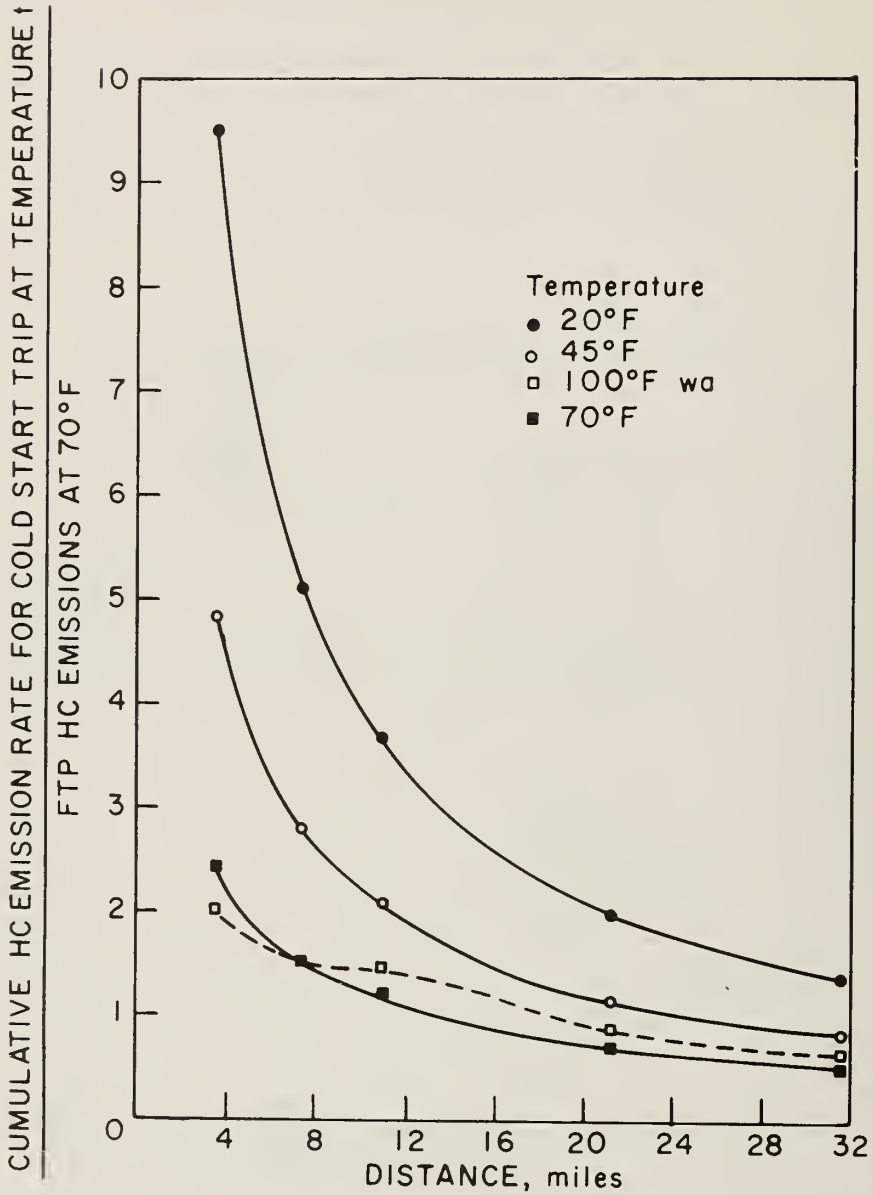


FIGURE 14. - Trip Length and Temperature Effect on Average Hydrocarbon Emission Rate Relative to the Federal Test Procedure Emission Rate--100° F Test Conducted with Air Conditioner in Operation.

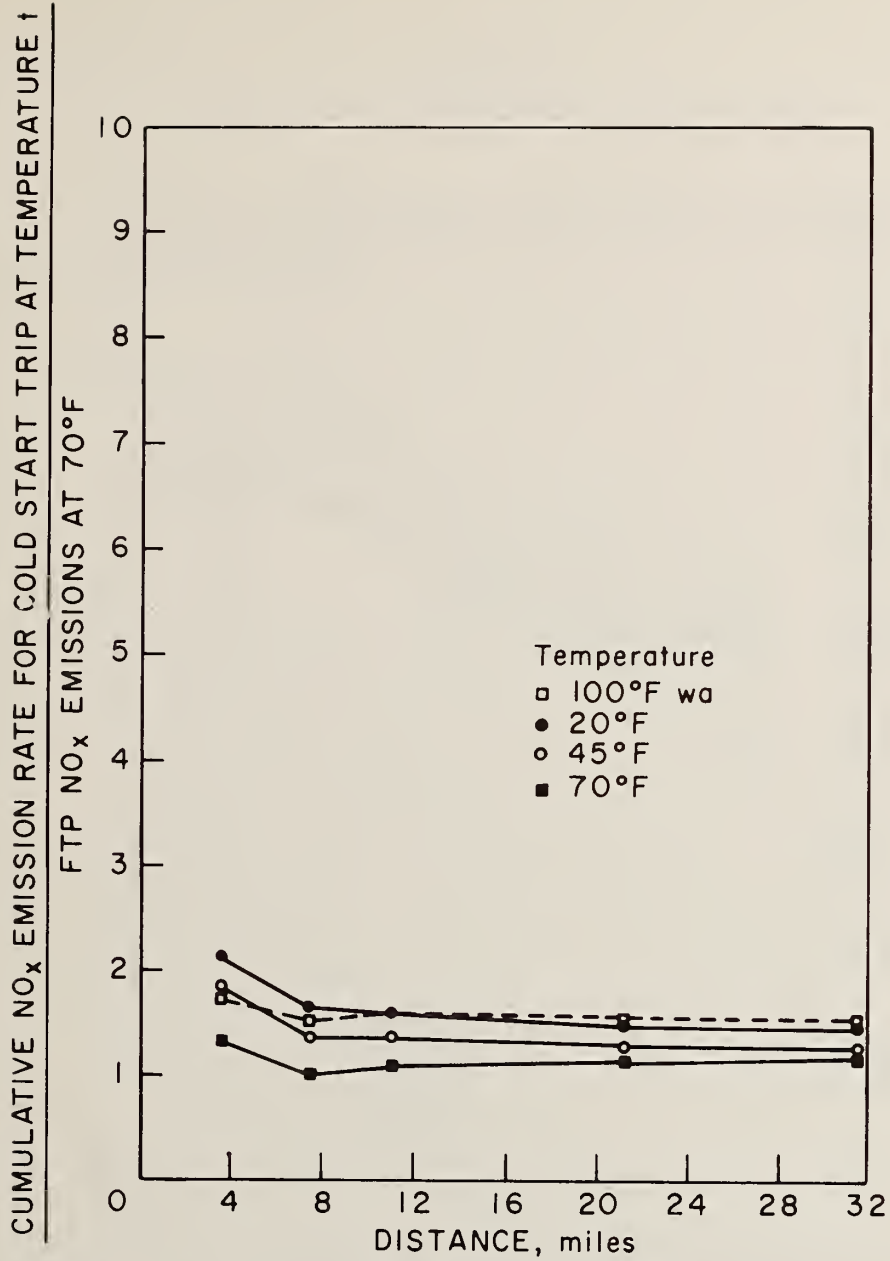


FIGURE 15. - Trip Length and Temperature Effect on the Average Oxides of Nitrogen Emission Rate Relative to the Federal Test Procedure Emission Rate--100° F Test Conducted with Air Conditioner in Operation.

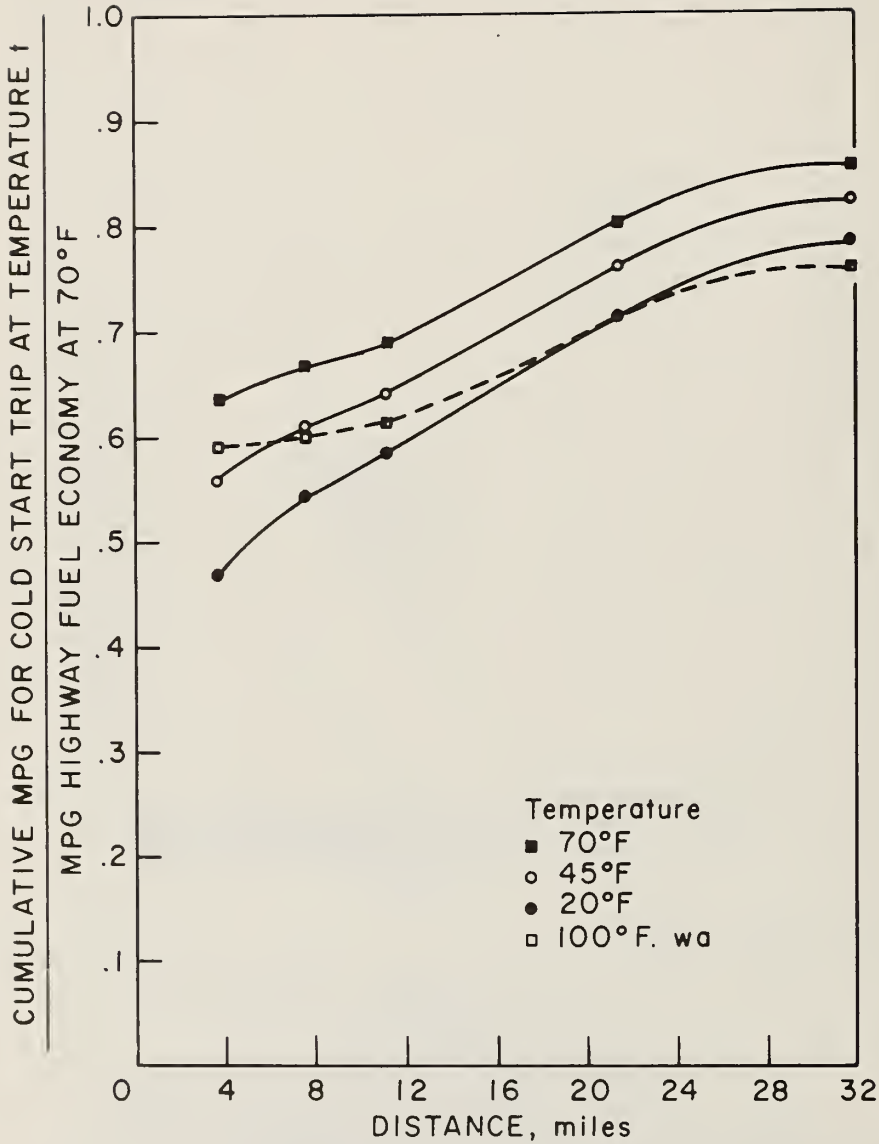


FIGURE 16. - Effect of Cold\*Start Trip Length (Using FTP and HWFET Driving Cycles) and Ambient Temperature on Fuel Economy Relative to Warm Vehicle Highway Fuel Economy--100° F Ambient with Air Conditioner in Operation.

APPENDIX A  
VEHICLE DESCRIPTION AND FUEL INSPECTION DATA

This appendix consists of two tables which list the vehicle description and fuel inspection data.

TABLE A-1. - Vehicle description

ERDA/FESR No.....	156	157	158	159
Manufacturer.....	Ford	Plymouth	Oldsmobile	Chevrolet
Model.....	Pinto	Gran Fury	Cutlass	Nova Concours
Body style.....	3 Door sedan	4 Door sedan	2 Door sedan	4 Door sedan
Vehicle ID No.....	7S11Y105187	PH41N7D188908	3J57R7R116545	1Y69D7K114659
Engine.....	4 Cylinder	V8	V8	6 Cylinder
Displacement, cubic inch.....	140 (2.3 L)	400	350	250
Carburetor venturi.....	2V	4V	4V	1V
Compression ratio.....	9.0	8.2	8.0	8.3
Rated horsepower.....	89	190	170	110
Transmission.....	Auto XP-C3	Auto	Auto	Auto
Axle ratio.....	3.18	2.71	2.41	2.73 (7FC)
Date assembled.....	8/76	1/77	9/76	10/76
Air conditioning.....	Yes	Yes	Yes	Yes
Curb weight.....	2428	4250	3913	3469
Actual weight.....	2640	4610	4000	3702
Fuel capacity, gal.....	13.0	26.5	22.0	21.0
Color.....	Dk. blue	Lt. blue	White	White
Tires.....	Goodyear Bias	Firestone Radial	Goodyear Radial	Goodrich Radial
	A78-13	Glass belted	Steel belted	Steel belted
		HR 78-15	GR 78-15	FR 78-14
Emissions controls:				
AIR.....	No	No	No	No
Catalyst.....	Yes	Yes	Yes	Yes
EGR.....	Yes	Yes	Yes	Yes
Power:				
Power steering.....	Yes	Yes	Yes	Yes
Power brakes.....	No	Yes	Yes	Yes
Cruise control.....	No	Yes	Yes	No
License tag.....	ZA2113	D2436	WH2591	ZC5349
Inertia weight used, lbs.....	3,000	5,000	4,500	4,000
Odometer first test.....	4046	4546	3980	3825
Odometer last test.....	5800	5486	6000	4350



TABLE A-2. - Fuel inspection data

Fuel designation.....	7704	7705
Distillation, °F:		
Initial boiling point.....	89	77
5 pct distilled.....	118	96
10 pct       ".....	134	108
20 pct       ".....	164	132
30 pct       ".....	191	160
40 pct       ".....	210	188
50 pct       ".....	222	214
60 pct       ".....	232	238
70 pct       ".....	242	261
80 pct       ".....	265	290
90 pct       ".....	310	331
95 pct       ".....	361	374
End point.....	395	390
Recovery, vol pct.....	97.5	95.5
Loss, vol pct.....	1.5	3.5
Reid vapor pressure, psi.....	8.6	12.9
Gravity, ° API.....	60.6	60.8
Octane number:		
ASTM Motor.....	88.4	83.0
ASTM Research.....	98.1	92.4
Hydrocarbon type, GLC vol pct:		
Paraffins.....	67	61
Olefins.....	5	10
Aromatics.....	28	29

APPENDIX B  
FUEL CONSUMPTION AND EMISSION PER PHASE

This appendix consists of four tables which list the average of three replicate fuel economy and emissions test results for each of four vehicles at four temperatures. Listed are fuel and emissions rate for each of the five test phases. The emissions listed are CO, CO<sub>2</sub>, HC, and NO<sub>x</sub>. The phases and cumulative distances in miles to the end of the phase are cold transient (3.6), stabilized (7.5), hot transient (11.1), highway fuel economy #1 (21.3), and highway fuel economy #2 (31.6).

TABLE B-1.- Rate of fuel consumption and emissions  
per phase (Vehicle No. 156)

Phase	Fuel <sup>1</sup>		Emissions, grams/mile/phase <sup>1</sup>			
	Grams/ mile/phase	Miles/ gallon/phase	CO	CO <sub>2</sub>	HC	NO <sub>x</sub>
20° F						
Cold transient	212	13.2	89.5	512	5.44	2.36
Stabilized	159	17.5	25.5	458	1.44	1.69
Hot transient	148	18.9	14.5	442	0.77	2.84
HWFET - 1 <sup>2</sup>	111	25.1	2.4	346	0.15	2.85
HWFET - 2 <sup>2</sup>	105	26.5	1.8	330	0.11	2.78
45° F						
Cold transient	175	15.9	51.6	465	2.38	2.00
Stabilized	148	18.8	14.1	443	0.89	1.38
Hot transient	139	20.1	8.3	424	0.47	2.39
HWFET - 1 <sup>2</sup>	105	26.5	1.7	329	0.13	2.55
HWFET - 2 <sup>2</sup>	101	27.5	1.5	318	0.11	2.45
70° F						
Cold transient	156	17.9	24.6	448	1.58	2.32
Stabilized	140	20.0	8.8	426	0.56	1.06
Hot transient	132	21.1	7.5	405	0.44	2.06
HWFET - 1 <sup>2</sup>	103	27.1	1.7	322	0.12	2.44
HWFET - 2 <sup>2</sup>	100	27.8	1.6	314	0.10	2.40
100° F w/a <sup>3</sup>						
Cold transient	170	16.4	26.8	489	1.66	3.05
Stabilized	168	16.6	33.3	473	1.75	2.26
Hot transient	156	17.9	26.5	446	1.30	2.71
HWFET - 1 <sup>2</sup>	119	23.4	7.8	363	0.32	2.27
HWFET - 2 <sup>2</sup>	118	23.6	7.8	360	0.29	2.17

<sup>1</sup>Average of triplicate tests.

<sup>2</sup>Highway Fuel Economy Test.

<sup>3</sup>With air conditioning.

TABLE B-2.- Rate of fuel consumption and emissions  
per phase (Vehicle No. 157)

Phase	Fuel <sup>1</sup>		Emissions, grams/mile/phase <sup>1</sup>			
	Grams/ mile/phase	Miles/ gallon/phase	CO	CO <sub>2</sub>	HC	NO <sub>x</sub>
20° F						
Cold transient	360	7.7	133.1	909	6.43	2.20
Stabilized	276	10.1	19.2	838	1.08	1.21
Hot transient	244	11.4	5.9	761	0.42	1.73
HWFET - 1 <sup>2</sup>	176	15.8	0.5	555	0.08	1.93
HWFET - 2 <sup>2</sup>	169	16.5	0.3	532	0.07	2.10
45° F						
Cold transient	306	9.1	53.8	875	2.09	1.89
Stabilized	257	10.8	12.2	790	1.03	1.99
Hot transient	258	10.8	3.8	807	0.39	2.01
HWFET - 1 <sup>2</sup>	182	15.3	0.5	575	0.09	1.61
HWFET - 2 <sup>2</sup>	175	15.9	0.3	552	0.09	1.70
70° F						
Cold transient	272	10.3	14.4	832	1.40	1.88
Stabilized	249	11.2	7.3	773	0.67	1.35
Hot transient	242	11.5	1.7	762	0.27	2.06
HWFET - 1 <sup>2</sup>	181	15.4	0.3	570	0.08	1.45
HWFET - 2 <sup>2</sup>	175	16.0	0.2	551	0.07	1.59
100° F w/a <sup>3</sup>						
Cold transient	297	9.4	7.1	925	0.97	2.50
Stabilized	280	10.0	2.4	880	0.30	2.30
Hot transient	275	10.2	3.0	861	0.33	3.09
HWFET - 1 <sup>2</sup>	203	13.8	0.3	639	0.05	2.32
HWFET - 2 <sup>2</sup>	189	14.7	0.2	597	0.06	2.94

<sup>1</sup>Average of triplicate tests.

<sup>2</sup>Highway Fuel Economy Test.

<sup>3</sup>With air conditioning.

TABLE B-3.- Rate of fuel consumption and emissions  
per phase (Vehicle No. 158)

Phase	Fuel <sup>1</sup>		Emissions, grams/mile/phase <sup>1</sup>			
	Grams/ mile/phase	Miles/ gallon/phase	Co	CO <sub>2</sub>	HC	NO <sub>x</sub>
20° F						
Cold transient	305	9.1	153.3	699	7.57	5.74
Stabilized	221	12.6	0.0	699	0.25	2.87
Hot transient	206	13.5	5.0	643	0.29	1.76
HWFET - 1 <sup>2</sup>	154	18.0	0.2	437	0.08	1.45
HWFET - 2 <sup>2</sup>	150	18.6	0.2	474	0.05	1.42
45° F						
Cold transient	261	10.7	100.5	651	5.18	4.65
Stabilized	224	12.5	0.3	705	0.27	1.03
Hot transient	198	14.1	5.0	615	0.45	1.56
HWFET - 1 <sup>2</sup>	148	18.8	0.2	465	0.11	1.35
HWFET - 2 <sup>2</sup>	148	18.9	0.1	464	0.09	1.37
70° F						
Cold transient	232	12.0	15.9	701	2.17	1.57
Stabilized	216	12.9	0.1	683	0.23	1.10
Hot transient	201	13.9	5.8	624	0.45	1.48
HWFET - 1 <sup>2</sup>	148	18.8	0.1	468	0.11	1.39
HWFET - 2 <sup>2</sup>	144	19.4	0.2	454	0.09	1.37
100° F w/a <sup>3</sup>						
Cold transient	244	11.5	13.3	743	1.66	2.24
Stabilized	238	11.7	0.5	750	0.24	2.13
Hot transient	219	12.7	15.9	663	1.27	2.47
HWFET - 1 <sup>2</sup>	168	16.6	1.4	528	0.14	2.04
HWFET - 2 <sup>2</sup>	164	17.0	1.7	515	0.12	2.14

<sup>1</sup>Average of triplicate tests.

<sup>2</sup>Highway Fuel Economy Test.

<sup>3</sup>With air conditioning.

TABLE B-4.- Rate of fuel consumption and emissions  
per phase (Vehicle No. 159)

Phase	Fuel <sup>1</sup>		Emissions, grams/mile/phase <sup>1</sup>			
	Grams/ mile/phase	Miles/ gallon/phase	CO	CO <sub>2</sub>	HC	NO <sub>x</sub>
----- 20° F -----						
Cold transient	288	9.7	188.5	582	10.36	2.00
Stabilized	201	13.8	3.8	628	0.66	1.47
Hot transient	185	15.1	5.6	573	0.60	2.49
HWFET - 1 <sup>2</sup>	137	20.3	1.1	430	0.14	2.29
HWFET - 2 <sup>2</sup>	133	20.9	0.8	420	0.08	2.24
----- 45° F -----						
Cold transient	240	11.6	103.1	577	5.61	2.27
Stabilized	190	14.7	4.1	591	0.66	1.21
Hot transient	177	15.7	2.2	555	0.46	2.32
HWFET - 1 <sup>2</sup>	136	20.6	0.3	427	0.12	1.85
HWFET - 2 <sup>2</sup>	132	21.1	0.3	416	0.08	1.87
----- 70° F -----						
Cold transient	206	13.6	48.6	566	2.41	2.33
Stabilized	179	15.6	3.8	557	0.67	0.92
Hot transient	169	16.5	2.5	527	0.53	2.05
HWFET - 1 <sup>2</sup>	131	21.3	0.2	413	0.11	2.04
HWFET - 2 <sup>2</sup>	129	21.6	0.1	401	0.07	2.06
----- 100° F w/a <sup>3</sup> -----						
Cold transient	219	12.7	27.2	642	2.12	2.73
Stabilized	211	13.2	12.9	644	1.12	1.41
Hot transient	192	14.5	13.4	581	1.25	2.17
HWFET - 1 <sup>2</sup>	148	18.8	1.7	466	0.18	2.35
HWFET - 2 <sup>2</sup>	147	19.0	2.5	460	0.15	2.22

<sup>1</sup>Average of triplicate tests.

<sup>2</sup>Highway Fuel Economy Test.

<sup>3</sup>With air conditioning.



APPENDIX C  
CUMULATIVE FUEL CONSUMPTION, EMISSIONS AND TRIP DISTANCE

Appendix C contains four tables and 16 figures presenting the cumulative fuel consumption and emissions derived from the data of Appendix B. If it can be assumed that the combined FTP and HWFET driving schedules represent, to an extent, the way a vehicle is driven from a cold start, then data presented in this fashion will most nearly represent fuel economy and emissions for various trip lengths and ambient temperatures.

TABLE C-1.- Cumulative fuel consumption, emissions,  
and trip distance (Vehicle No. 156)

Distance, miles	Fuel <sup>1</sup>		Emissions, grams/mile <sup>1</sup>			
	Grams/ mile	Miles/ gallon	CO	CO <sub>2</sub>	HC	NO <sub>x</sub>
20° F						
3.59	212	13.2	89.5	511	5.44	2.36
7.50	184	15.1	56.1	484	3.36	2.01
11.09	172	16.2	42.6	470	2.52	2.28
21.33	143	19.5	23.3	411	1.38	2.55
31.57	131	21.3	16.3	384	0.97	2.63
45° F						
3.59	175	15.9	51.6	465	2.38	2.00
7.50	161	17.3	32.0	453	1.60	1.68
11.09	154	18.1	24.4	444	1.24	1.91
21.33	131	21.4	13.5	389	0.70	2.22
31.57	121	23.0	9.6	366	0.51	2.29
70° F						
3.59	156	17.9	24.6	448	1.58	2.32
7.50	147	18.9	16.3	436	1.05	1.66
11.09	142	19.6	13.5	426	0.85	1.79
21.33	123	22.6	7.8	376	0.50	2.10
31.57	116	24.0	5.8	356	0.37	2.20
100° F w/a <sup>2</sup>						
3.59	170	16.4	26.8	489	1.66	3.05
7.50	169	16.5	30.2	481	1.71	2.64
11.09	165	16.9	29.0	469	1.58	2.66
21.33	143	19.6	18.8	418	0.98	2.47
31.57	135	20.7	15.2	399	0.75	2.38

<sup>1</sup>Average of triplicate tests.

<sup>2</sup>With air conditioning.

TABLE C-2. - Cumulative fuel consumption, emissions,  
and trip distance (Vehicle No. 157)

Distance, miles	Fuel <sup>1</sup>		Emissions, grams/mile <sup>1</sup>			
	Grams/ mile	Miles/ gallon	CO	CO <sub>2</sub>	HC	NO <sub>x</sub>
----- 20° F -----						
3.59	360	7.7	133.1	909	6.43	2.20
7.50	316	8.8	73.7	872	3.64	1.68
11.09	293	9.5	51.8	836	2.59	1.70
21.33	237	11.8	27.2	701	1.39	1.81
31.57	215	13.0	18.5	646	0.96	1.91
----- 45° F -----						
3.59	306	9.1	53.8	875	2.09	1.89
7.50	280	9.9	32.1	830	1.54	1.94
11.09	273	10.2	23.0	823	1.17	1.96
21.33	230	12.1	12.2	704	0.65	1.79
31.57	212	13.2	8.3	655	0.47	1.76
----- 70° F -----						
3.59	272	10.3	14.4	832	1.40	1.88
7.50	260	10.7	10.7	801	1.02	1.60
11.09	254	11.0	7.8	789	0.78	1.75
21.33	219	12.7	4.2	684	0.44	1.61
31.57	205	13.6	2.9	641	0.32	1.60
----- 100° F w/a <sup>2</sup> -----						
3.59	297	9.4	7.1	925	0.97	2.50
7.50	288	9.7	4.6	902	0.62	2.40
11.09	284	9.8	4.1	889	0.53	2.62
21.33	245	11.4	2.3	769	0.30	2.48
31.57	227	12.3	1.6	713	0.22	2.63

<sup>1</sup>Average of triplicate tests.

<sup>2</sup>With air conditioning.

TABLE C-3.- Cumulative fuel consumption, emissions,  
and trip distance (Vehicle No. 158)

Distance, miles	Fuel <sup>1</sup>		Emissions, grams/mile <sup>1</sup>			
	Grams/ mile	Miles/ gallon	CO	CO <sub>2</sub>	HC	NO <sub>x</sub>
----- 20° F -----						
3.59	305	9.1	153.3	699	7.57	5.74
7.50	261	10.7	73.4	699	3.75	4.24
11.09	244	11.4	51.2	681	2.63	3.44
21.33	201	13.9	26.7	588	1.41	2.48
31.57	184	15.1	18.1	551	0.97	2.14
----- 45° F -----						
3.59	261	10.7	100.5	651	5.18	4.65
7.50	242	11.5	48.2	679	2.62	2.76
11.09	227	12.3	34.2	659	1.92	2.37
21.33	189	14.7	17.9	565	1.05	1.88
31.57	176	15.9	12.1	533	0.74	1.72
----- 70° F -----						
3.59	232	12.0	15.9	701	2.17	1.57
7.50	224	12.5	7.6	691	1.16	1.32
11.09	216	12.9	7.0	670	0.93	1.37
21.33	184	15.2	3.7	573	0.54	1.38
31.57	171	16.3	2.6	534	0.39	1.38
----- 100° F w/a <sup>2</sup> -----						
3.59	244	11.5	13.3	743	1.66	2.24
7.50	241	11.6	6.6	747	0.92	2.18
11.09	234	11.9	9.6	720	1.04	2.28
21.33	202	13.8	5.7	628	0.61	2.16
31.57	190	14.7	4.4	591	0.45	2.16

<sup>1</sup>Average of triplicate tests.

<sup>2</sup>With air conditioning.

TABLE C-4.- Cumulative fuel consumption, emissions,  
and trip distance (Vehicle No. 159)

Distance, miles	Fuel <sup>1</sup>		Emissions, grams/mile <sup>1</sup>			
	Grams/ mile	Miles/ gallon	CO	CO <sub>2</sub>	HC	NO <sub>x</sub>
----- 20° F -----						
3.59	288	9.7	188.5	582	10.36	2.00
7.50	243	11.5	92.2	606	5.30	1.73
11.09	224	12.4	64.2	595	3.78	1.97
21.33	182	15.3	33.9	516	2.03	2.13
31.57	166	16.8	23.1	485	1.40	2.16
----- 45° F -----						
3.59	240	11.7	103.1	577	5.61	2.27
7.50	214	13.1	51.5	584	3.03	1.72
11.09	202	13.8	35.5	575	2.20	1.91
21.33	170	16.4	18.6	504	1.20	1.88
31.57	158	17.7	12.7	476	0.84	1.88
----- 70° F -----						
3.59	206	13.6	48.6	566	2.41	2.33
7.50	192	14.5	25.3	561	1.50	1.60
11.09	184	15.1	18.0	550	1.19	1.75
21.33	159	17.6	9.4	485	0.67	1.89
31.57	149	18.7	6.4	458	0.48	1.94
----- 100° F w/a <sup>2</sup> -----						
3.59	219	12.7	27.2	642	2.12	2.73
7.50	215	13.0	19.8	643	1.59	2.04
11.09	208	13.4	17.7	623	1.48	2.08
21.33	179	15.6	10.0	547	0.86	2.21
31.57	169	16.5	7.6	519	0.63	2.21

<sup>1</sup>Average of triplicate tests.

<sup>2</sup>With air conditioning.

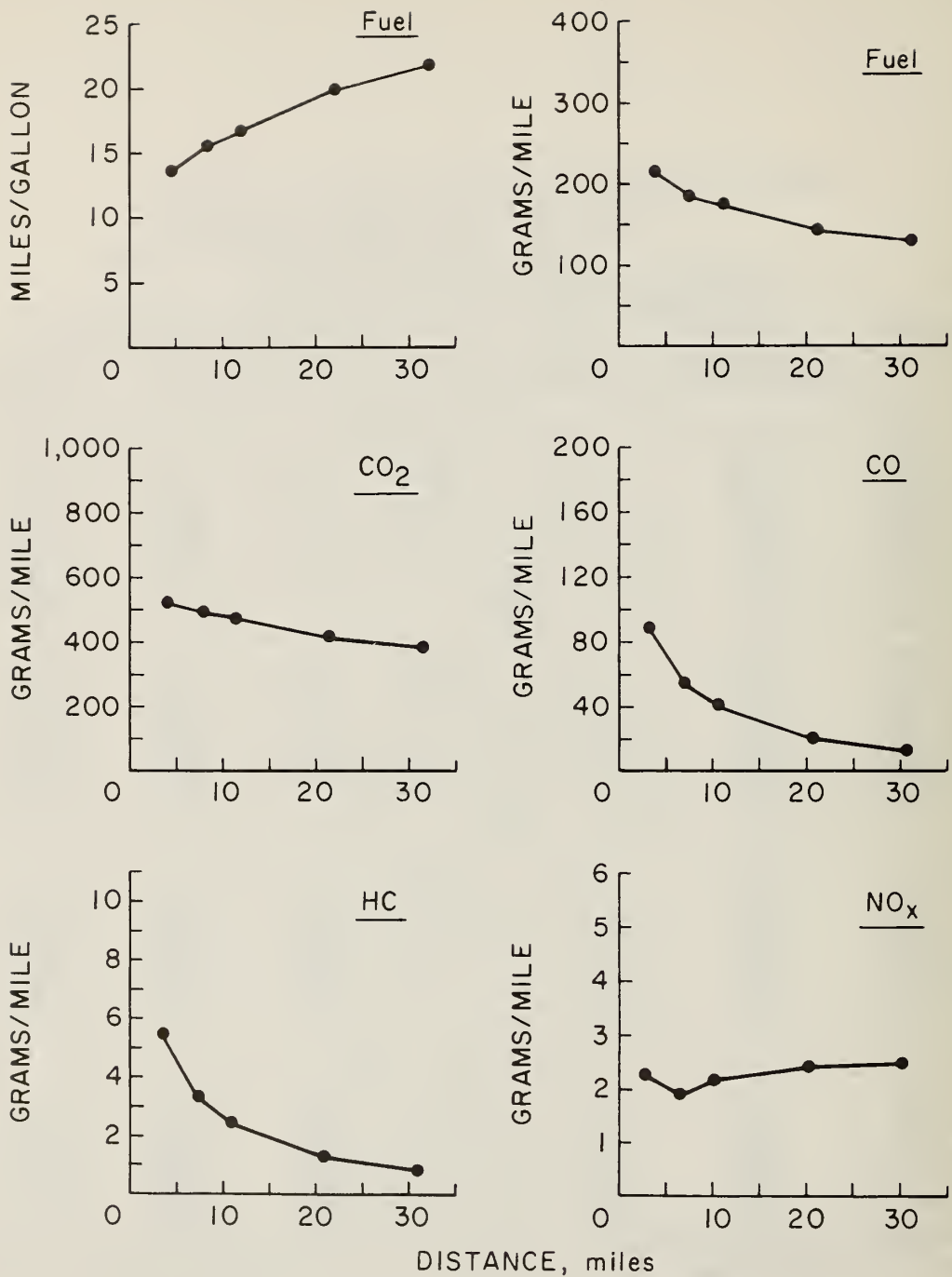


FIGURE C-1. - Trip-Length, Fuel, and Emissions--Vehicle No. 156, Temperature 20° F.



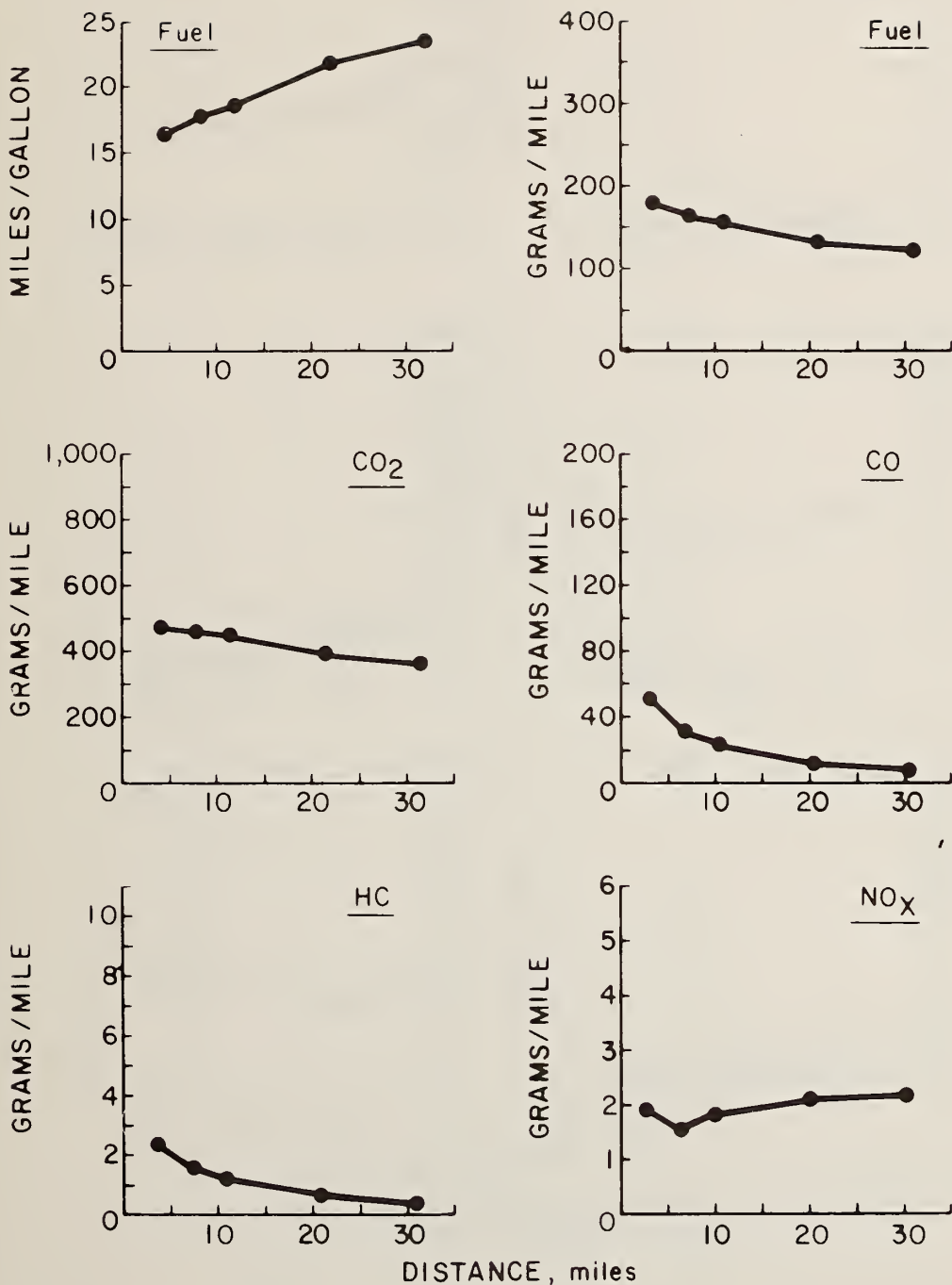


FIGURE C-2. - Trip-Length, Fuel, and Emissions--Vehicle No. 156, Temperature 45° F.

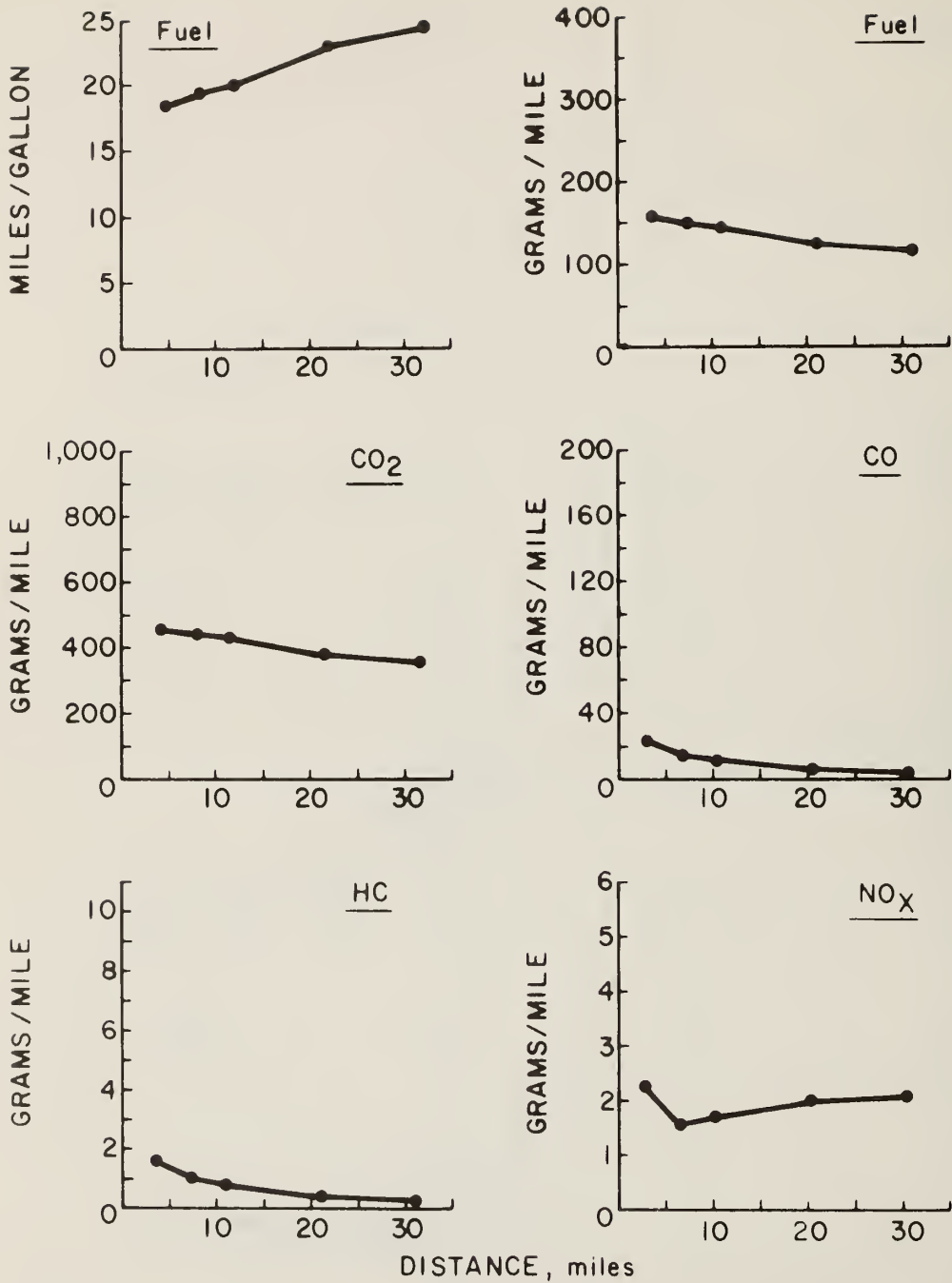


FIGURE C-3. - Trip-Length, Fuel, and Emissions--Vehicle No. 156, Temperature 70° F.

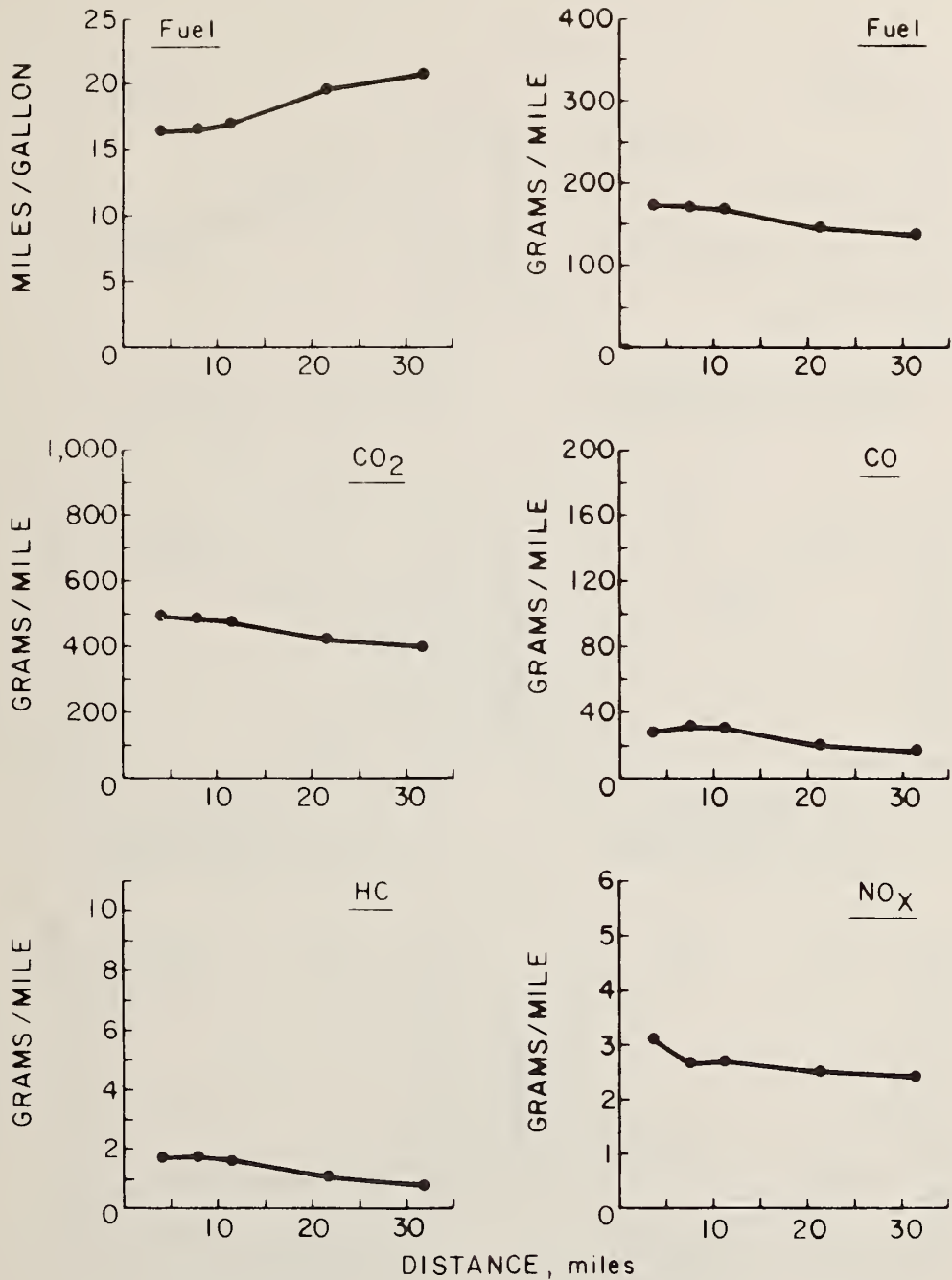


FIGURE C-4. - Trip-Length, Fuel, and Emissions--Vehicle No. 156, Temperature 100° F with Air Conditioning on.

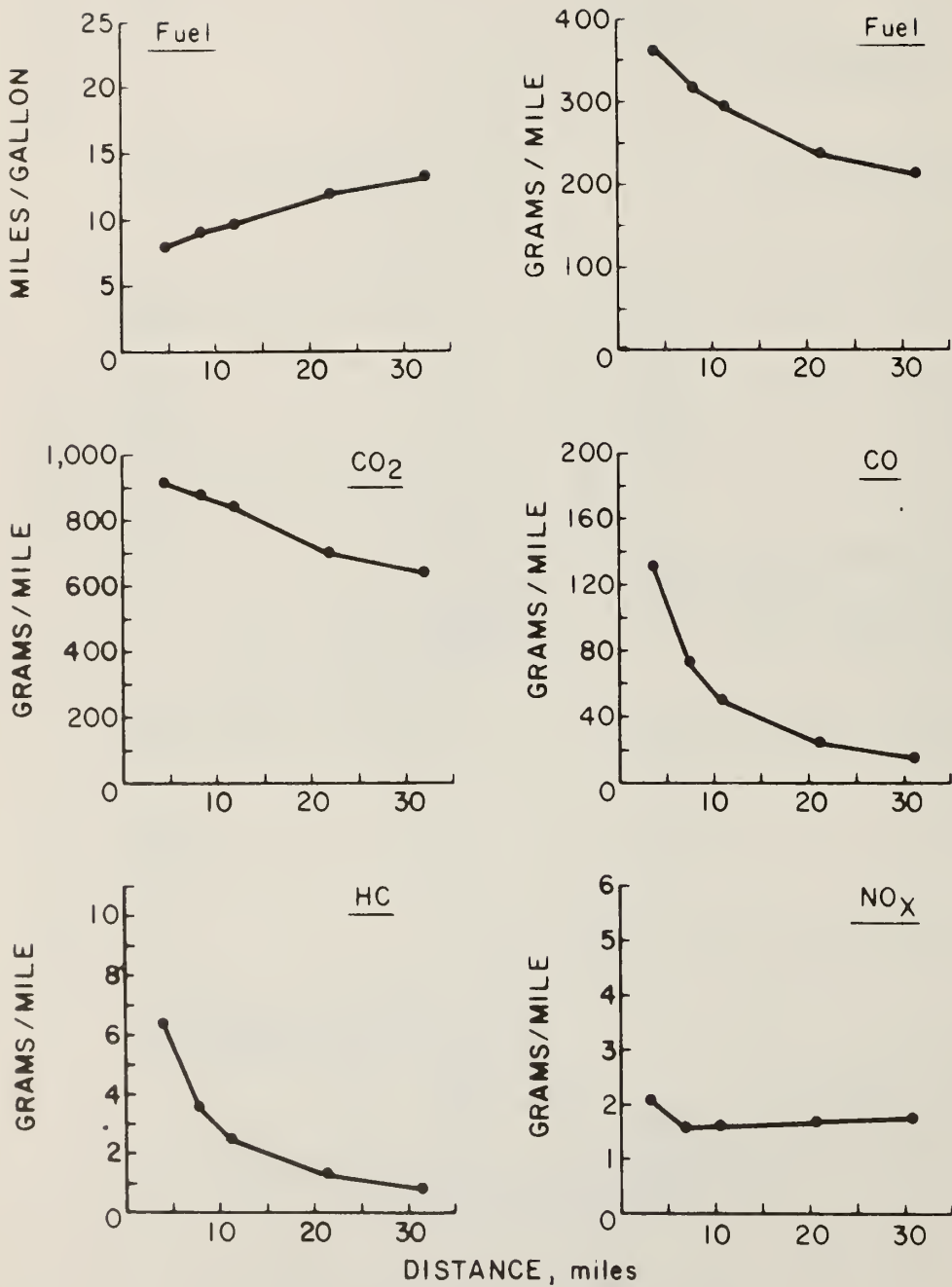


FIGURE C-5. - Trip-Length, Fuel, and Emissions--Vehicle No. 157, Temperature 20° F.

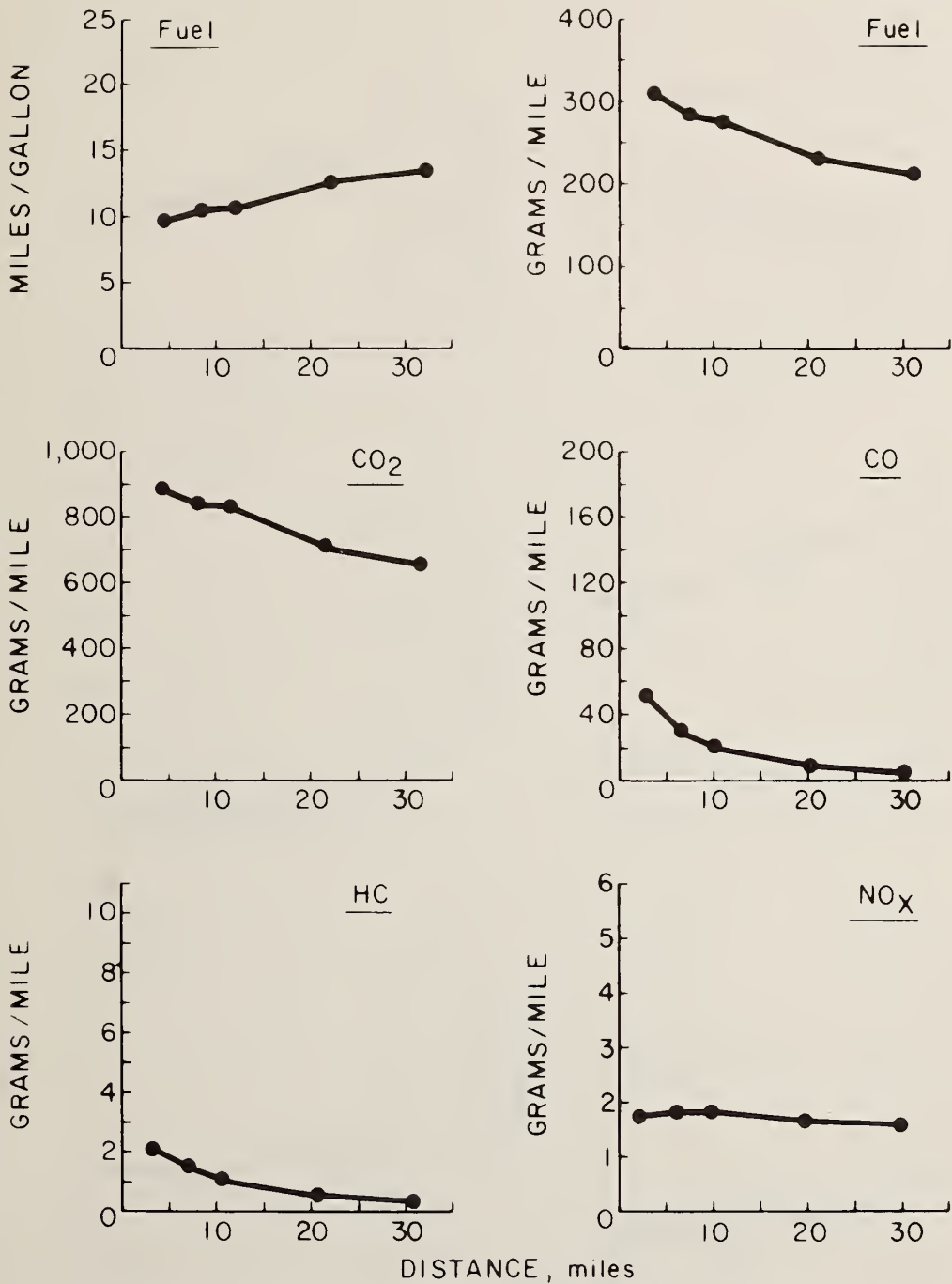
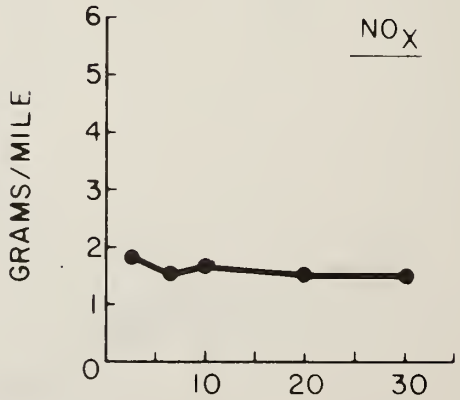
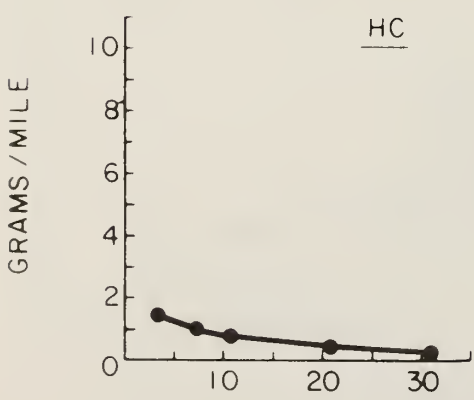
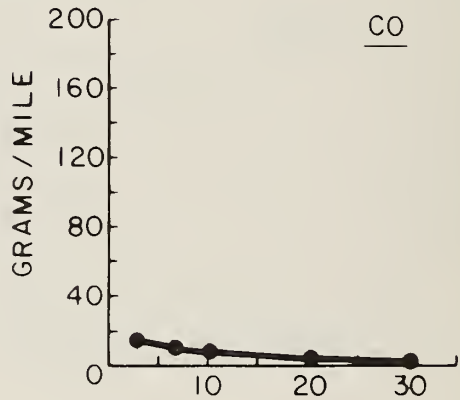
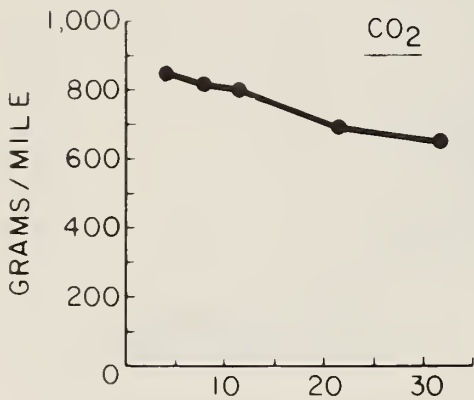
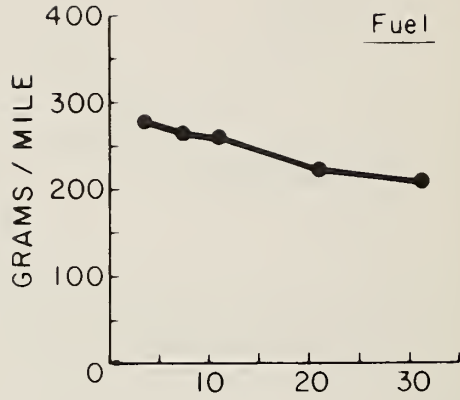
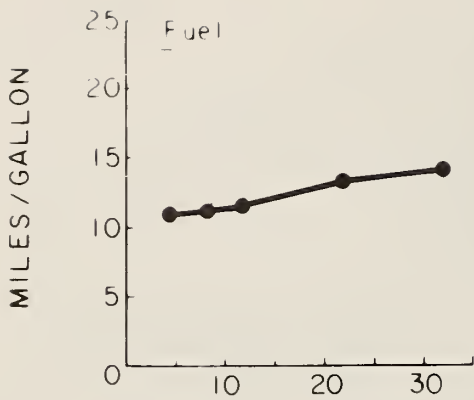


FIGURE C-6. - Trip-Length, Fuel, and Emissions--Vehicle No. 157, Temperature 45° F.



DISTANCE, miles

FIGURE C-7. - Trip-Length, Fuel, and Emissions--Vehicle No. 157, Temperature 70° F.



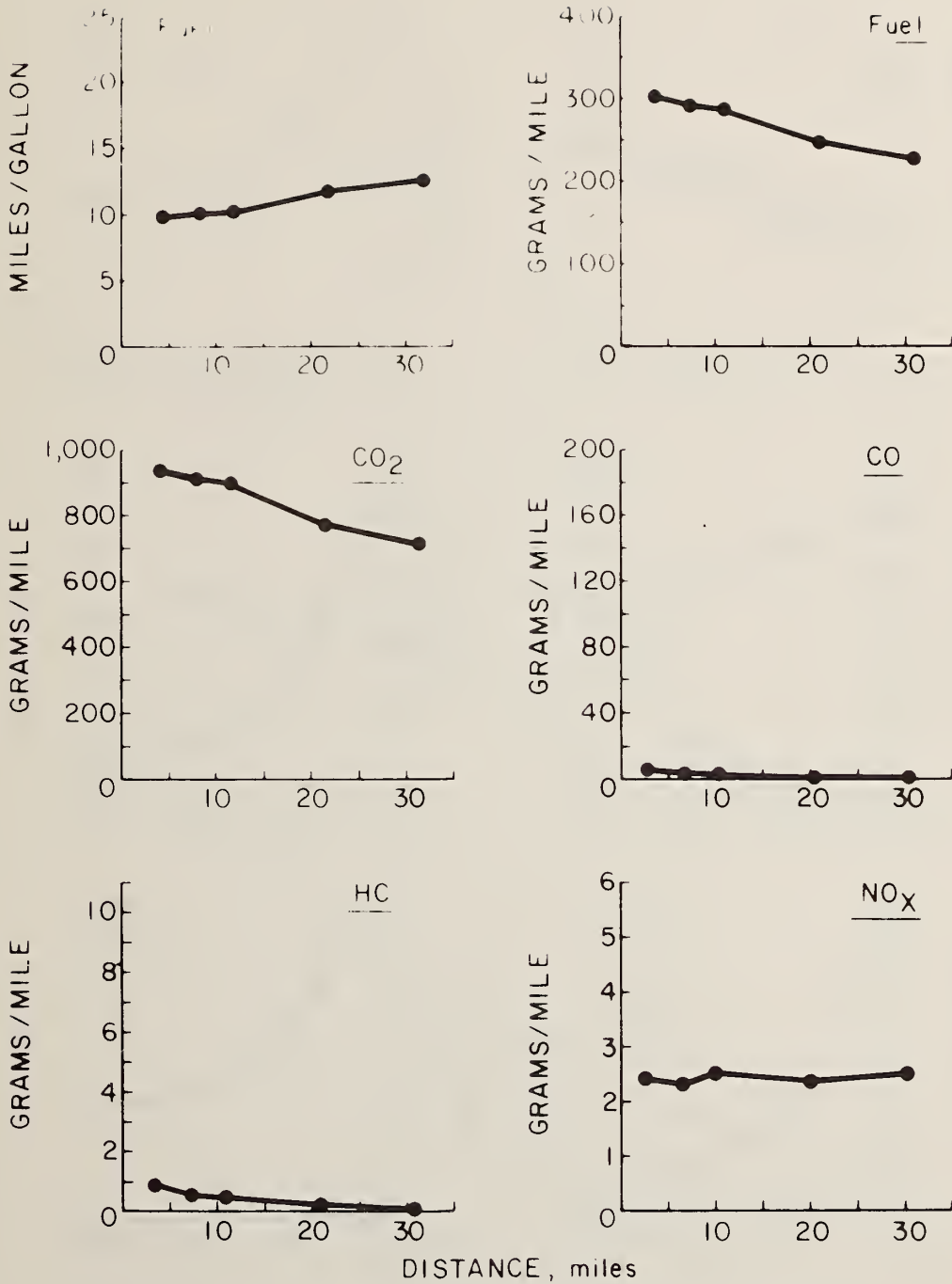
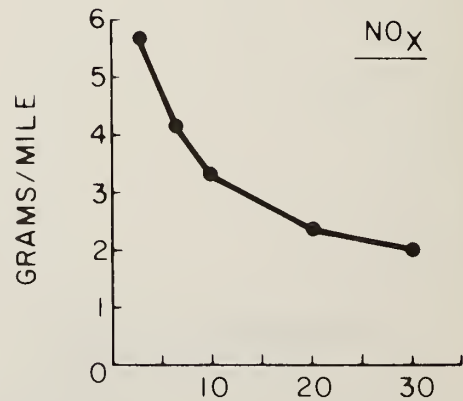
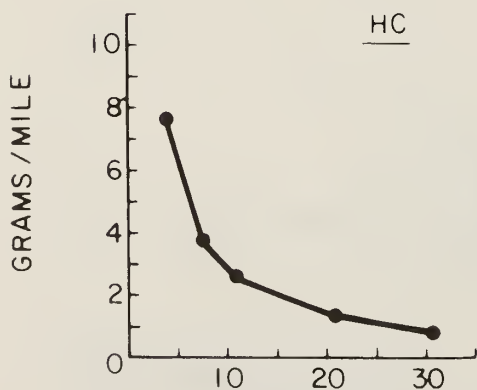
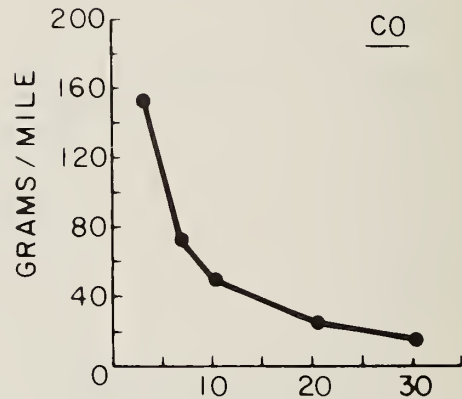
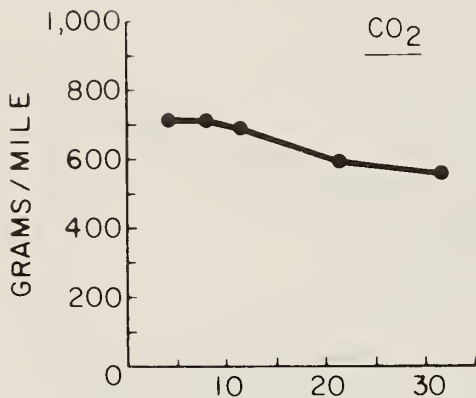
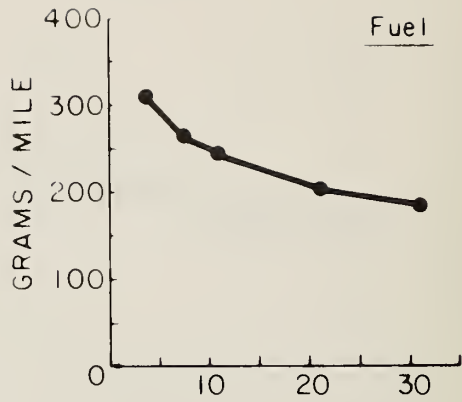
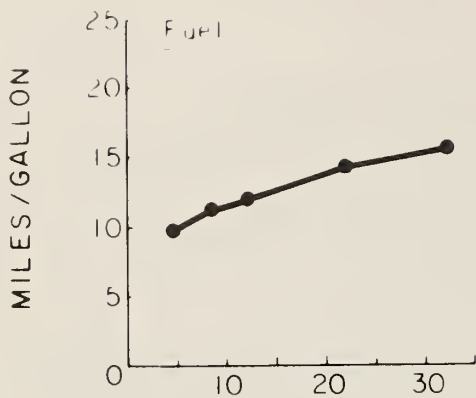


FIGURE C-8. - Trip-Length, Fuel, and Emissions--Vehicle No. 157, Temperature 100° F with Air Conditioning on.



DISTANCE, miles

FIGURE C-9. - Trip-Length, Fuel, and Emissions--Vehicle No. 158, Temperature 20° F.

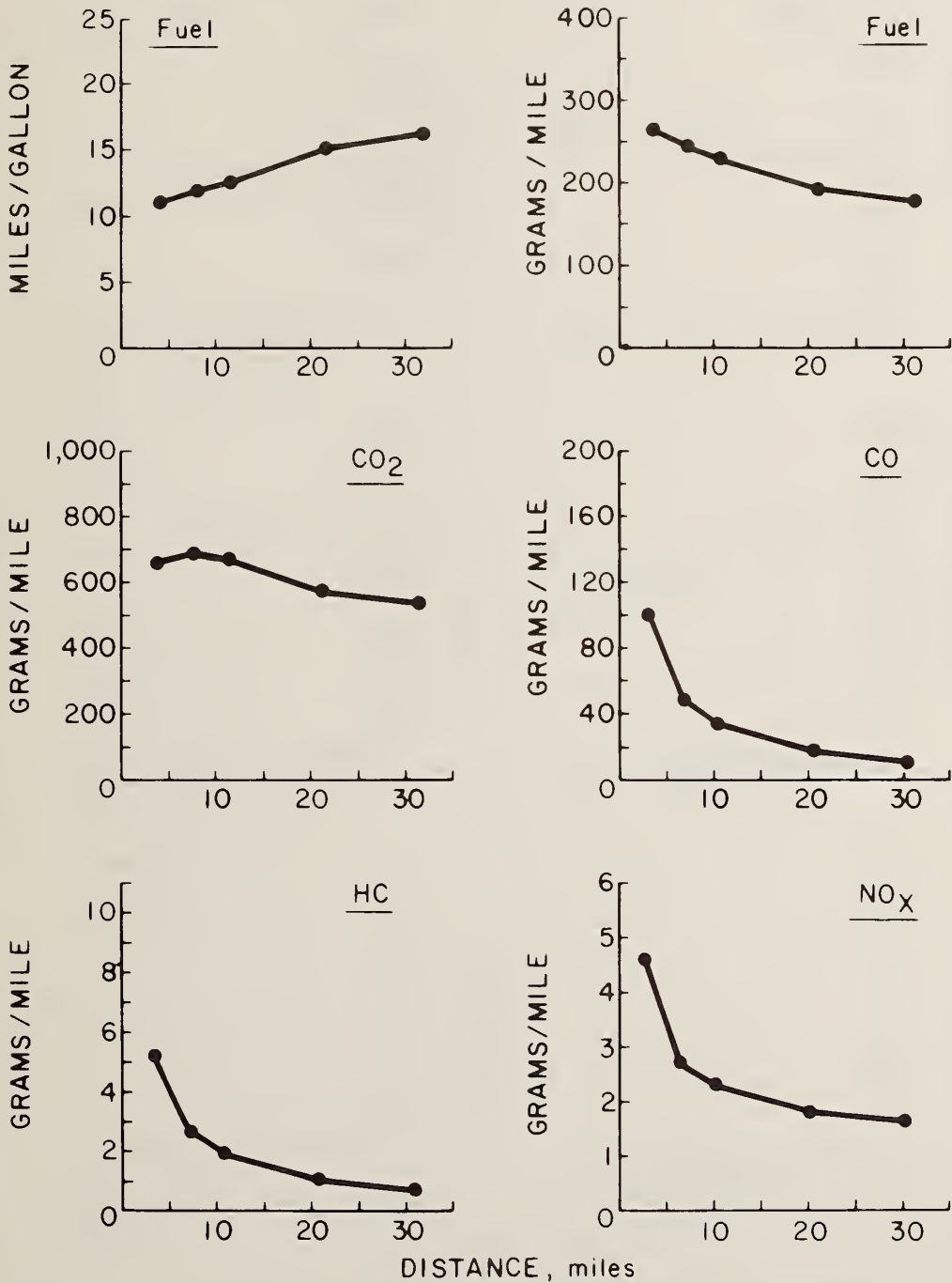


FIGURE C-10. - Trip-Length, Fuel, and Emissions--Vehicle No. 158, Temperature 45° F.

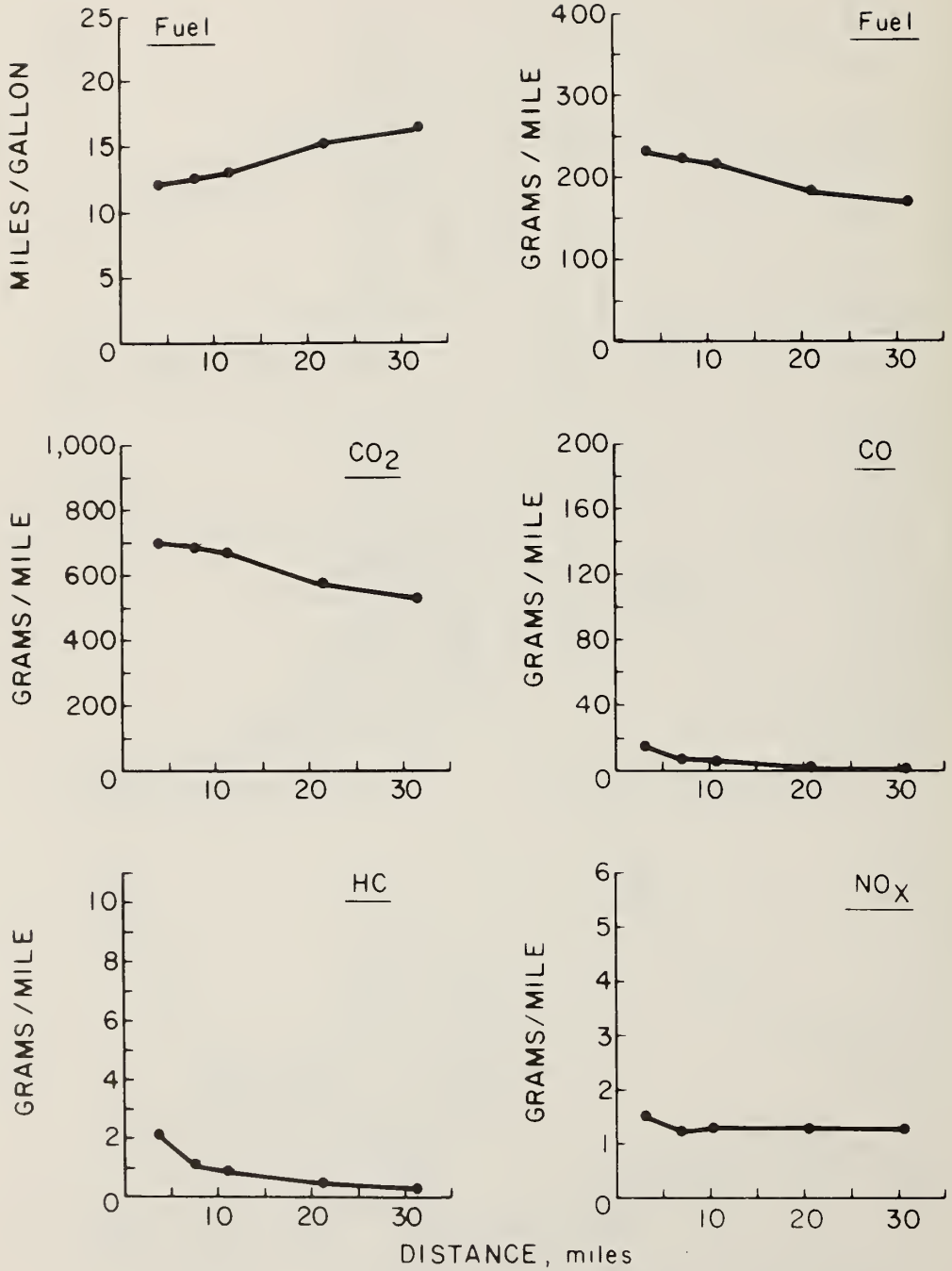


FIGURE C-11. - Trip-Length, Fuel, and Emissions--Vehicle No. 158, Temperature 70° F.

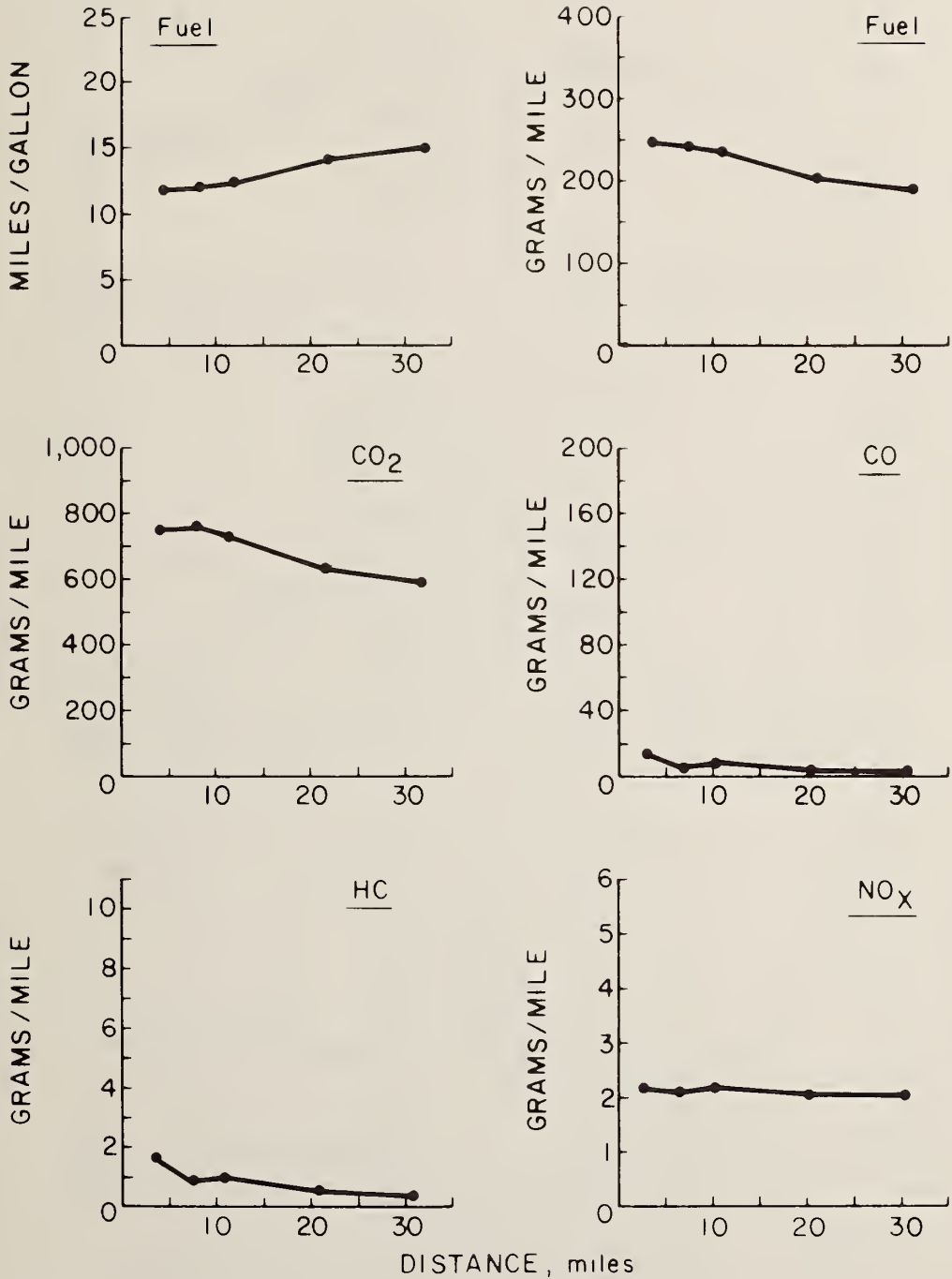


FIGURE C-12. - Trip-Length, Fuel, and Emissions--Vehicle No. 158, Temperature 100° F with Air Conditioning on.

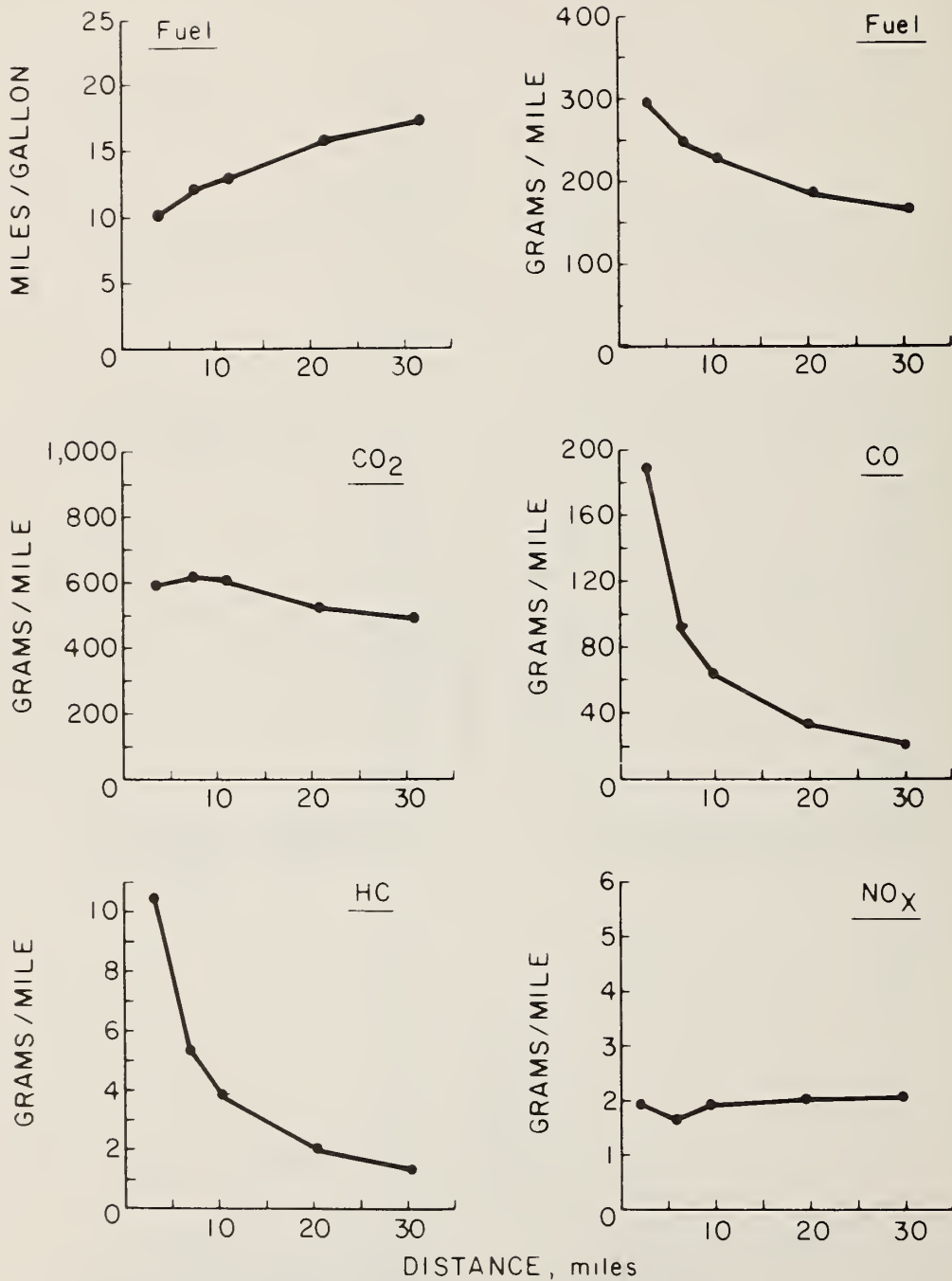


FIGURE C-13. - Trip-Length, Fuel, and Emissions--Vehicle No. 159, Temperature 20° F.



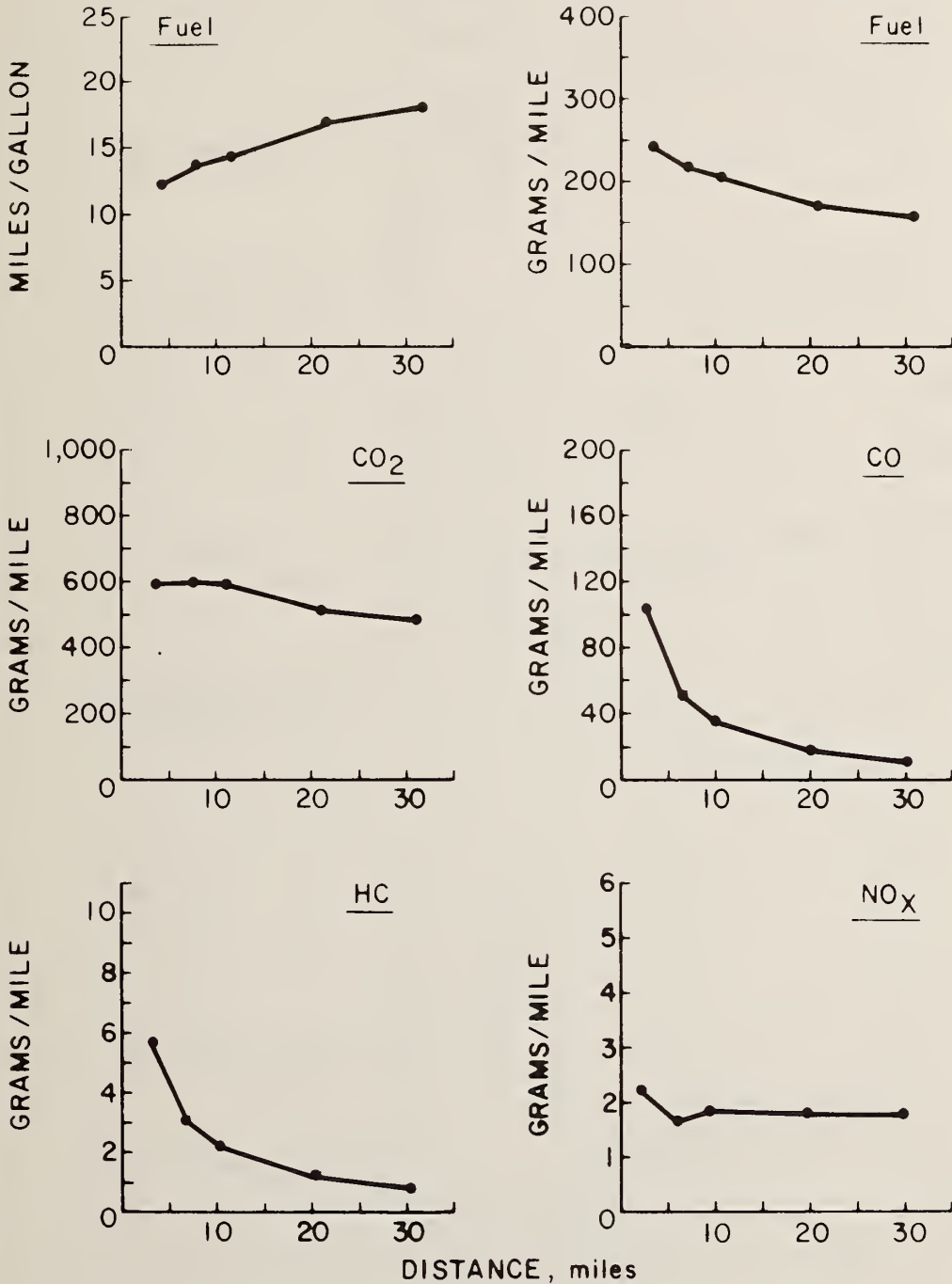
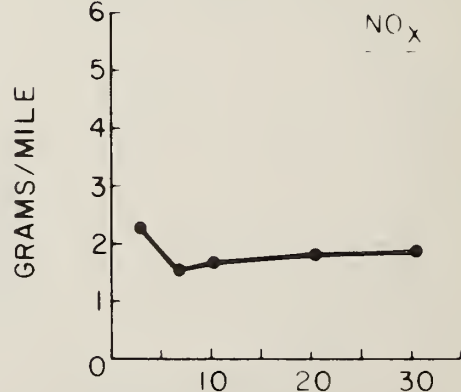
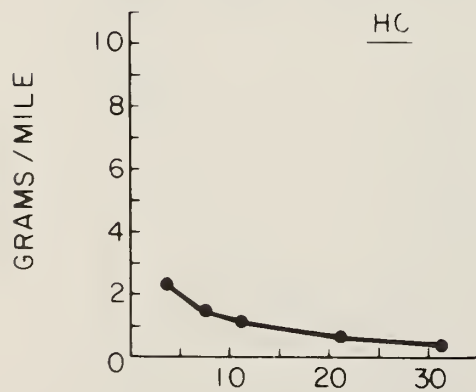
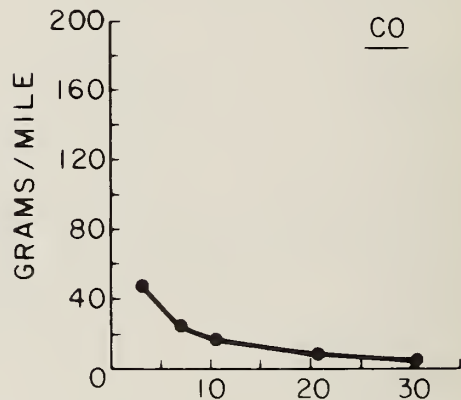
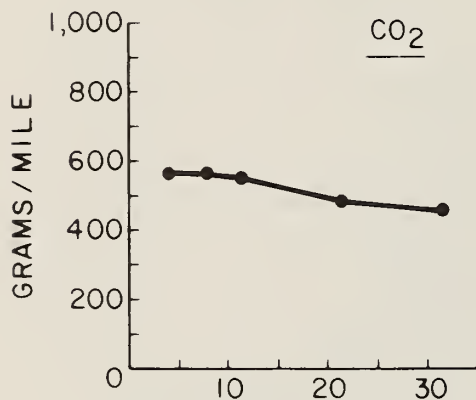
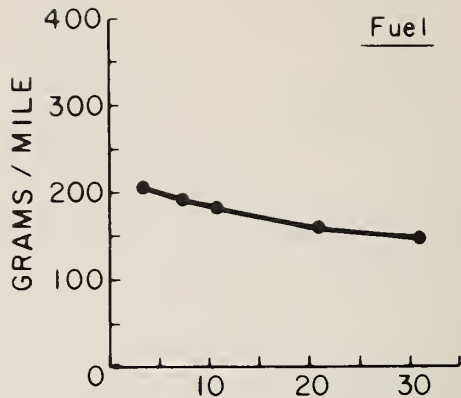
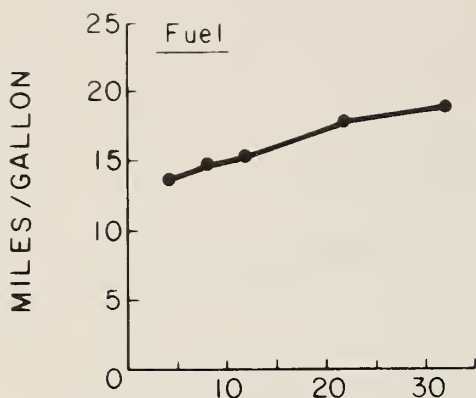


FIGURE C-14. - Trip-Length, Fuel, and Emissions--Vehicle No. 159, Temperature 45° F.



DISTANCE, miles

FIGURE C-15. - Trip-Length, Fuel, and Emissions--Vehicle No. 159, Temperature 70° F.

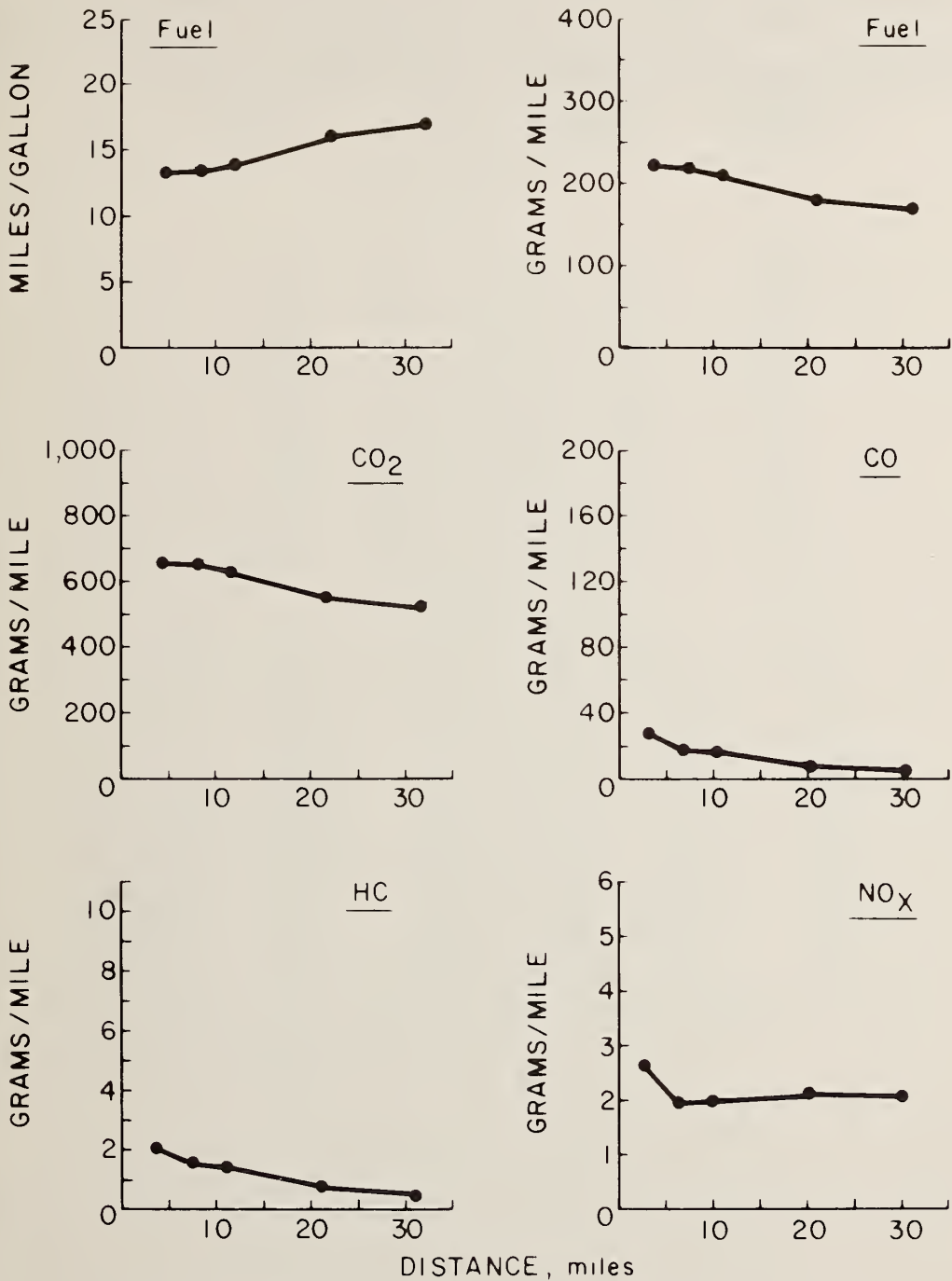


FIGURE C-16. - Trip-Length, Fuel, and Emissions--Vehicle No. 159, Temperature 100° F with Air Conditioning on.

APPENDIX D  
FTP FUEL CONSUMPTION AND DISTANCE

This appendix contains fuel consumption data obtained by continuous analysis of the dilute exhaust stream during the 11 miles of the FTP portion of the dynamometer cycle. The fuel consumed was calculated by the carbon balance procedure and a cumulative average of distance and fuel obtained.

TABLE D-1.- Cumulative fuel consumption<sup>1</sup> at 1-mile intervals of the Federal emissions test (Vehicle No. 156)

Time, minutes	Distance, miles	w/o air conditioner			w/air conditioner
		20° F	45° F	70°F	100° F
MILES PER GALLON					
3.3	0.90	8.1	11.3	14.1	13.9
4.3	1.79	10.4	13.3	15.7	15.0
6.0	2.69	12.5	15.4	17.9	16.7
8.5	3.59	13.2	15.9	18.0	16.5
12.6	4.53	13.5	16.0	17.8	15.8
15.0	5.54	14.6	17.2	19.0	16.7
18.6	6.53	15.2	17.6	19.4	16.8
22.9	7.50	15.2	17.4	19.1	16.4
36.2	8.44	15.3	17.4	19.1	16.2
37.3	9.24	15.6	17.7	19.2	16.4
38.9	10.14	16.1	18.2	19.7	16.8
41.4	11.04	16.2	18.2	19.8	16.8
GALLONS					
3.3	0.90	0.11	0.08	0.06	0.06
4.3	1.79	.17	.13	.11	.12
6.0	2.69	.22	.17	.15	.16
8.5	3.59	.27	.23	.20	.22
12.6	4.53	.34	.28	.25	.29
15.0	5.54	.38	.32	.29	.33
18.6	6.53	.43	.37	.34	.39
22.9	7.50	.49	.43	.39	.46
36.2	8.44	.55	.48	.44	.52
37.3	9.24	.59	.52	.48	.56
38.9	10.14	.63	.56	.51	.60
41.4	11.04	.68	.61	.56	.66

<sup>1</sup>Average of triplicate tests.

TABLE D-2.- Cumulative fuel consumption<sup>1</sup> at 1-mile intervals of the Federal emissions test (Vehicle No. 157)

Time, minutes	Distance, miles	w/o air conditioner			w/air conditioner
		20° F	45° F	70° F	100° F
MILES PER GALLON					
3.3	0.90	5.0	6.9	8.1	8.5
4.3	1.79	6.3	7.9	8.9	9.3
6.0	2.69	7.4	8.9	10.1	9.4
8.5	3.59	7.8	9.2	10.2	9.4
12.6	4.53	7.9	9.1	10.0	9.3
15.0	5.54	8.6	9.9	10.6	9.7
18.6	6.53	8.9	10.1	10.9	9.6
22.9	7.50	8.8	10.0	10.6	9.5
36.2	8.44	8.9	10.0	10.6	9.5
37.3	9.24	9.1	10.0	10.6	9.6
38.9	10.14	9.5	10.3	10.8	9.7
41.4	11.04	9.5	10.3	10.9	9.7
GALLONS					
3.3	0.90	0.18	0.13	0.11	0.11
4.3	1.79	.28	.23	.20	.20
6.0	2.69	.36	.30	.27	.29
8.5	3.59	.46	.39	.35	.38
12.6	4.53	.57	.50	.46	.49
15.0	5.54	.65	.56	.52	.57
18.6	6.53	.74	.64	.60	.68
22.9	7.50	.85	.75	.71	.79
36.2	8.44	.95	.84	.80	.89
37.3	9.24	1.01	.92	.87	.96
38.9	10.14	1.07	.99	.94	1.05
41.4	11.04	1.16	1.07	1.02	1.14

<sup>1</sup>Average of triplicate tests.



TABLE D-3.- Cumulative fuel consumption<sup>1</sup> at 1-mile intervals of the Federal emissions test (Vehicle No. 158)

Time, minutes	Distance, miles	w/o air conditioner			w/air conditioner
		20° F	45° F	70° F	100° F
MILES PER GALLON					
3.3	0.90	5.0	6.5	9.3	11.1
4.3	1.79	6.9	8.6	10.6	13.1
6.0	2.69	8.5	10.3	12.0	11.4
8.5	3.59	9.2	10.7	12.0	11.3
12.6	4.53	9.5	10.7	11.7	11.7
15.0	5.54	10.3	11.5	12.5	11.9
18.6	6.53	10.7	11.7	12.7	11.5
22.9	7.50	10.7	11.6	12.4	11.4
36.2	8.44	10.9	11.7	12.5	11.4
37.3	9.24	11.0	11.9	12.6	11.7
38.9	10.14	11.4	12.2	12.9	11.8
41.4	11.04	11.5	12.3	12.9	11.7
GALLONS					
3.3	0.90	0.18	0.14	0.10	0.08
4.3	1.79	.26	.21	.17	.14
6.0	2.69	.32	.26	.23	.24
8.5	3.59	.39	.33	.30	.32
12.6	4.53	.48	.43	.39	.39
15.0	5.54	.54	.48	.44	.47
18.6	6.53	.61	.56	.52	.57
22.9	7.50	.70	.65	.60	.66
36.2	8.44	.78	.72	.68	.74
37.3	9.24	.84	.78	.73	.79
38.9	10.14	.89	.83	.79	.86
41.4	11.04	.96	.90	.86	.94

<sup>1</sup>Average of triplicate tests.

TABLE D-4.- Cumulative fuel consumption<sup>1</sup> at 1-mile intervals of the Federal emissions test (Vehicle No. 159)

Time, minutes	Distance, miles	w/o air conditioner			w/air conditioner
		20° F	45° F	70° F	100° F
MILES PER GALLON					
3.3	0.90	5.9	7.7	10.3	11.0
4.3	1.79	7.6	8.6	13.6	13.0
6.0	2.69	9.1	11.5	13.6	12.7
8.5	3.59	9.8	11.8	13.6	12.5
12.6	4.53	10.2	11.9	13.9	12.6
15.0	5.54	11.1	12.9	14.6	13.1
18.6	6.53	11.6	13.4	14.6	13.1
22.9	7.50	11.7	13.3	14.6	12.8
36.2	8.44	11.8	13.4	14.7	12.8
37.3	9.24	12.1	13.6	15.0	13.1
38.9	10.14	12.5	14.0	15.2	13.2
41.4	11.04	12.6	14.0	15.2	13.2
GALLONS					
3.3	0.90	0.15	0.12	0.09	0.08
4.3	1.79	.24	.22	.14	.14
6.0	2.69	.29	.23	.20	.21
8.5	3.59	.37	.30	.26	.29
12.6	4.53	.45	.38	.33	.36
15.0	5.54	.50	.43	.38	.42
18.6	6.53	.56	.49	.45	.50
22.9	7.50	.64	.56	.51	.59
36.2	8.44	.71	.63	.57	.66
37.3	9.24	.77	.68	.62	.71
38.9	10.14	.81	.72	.67	.77
41.4	11.04	.88	.79	.73	.84

<sup>1</sup>Average of triplicate tests.

APPENDIX E  
VEHICLE TEMPERATURES--CYCLE DATA

Appendix E consists of tables and figures of vehicle temperature, time and distance for each of the four vehicles at each ambient temperature. The time and distance are nominal values taken from the driving schedule. The temperatures were obtained using thermocouples with the signal read by computer at designated intervals. The temperatures are essentially instantaneous. The temperature of the air to the vehicle was of the air stream about 3 feet in front of the vehicle. The temperature of air to the carburetor was that of the air inside the air silencer and the air filter element. The coolant temperature was obtained in the bypass stream, the oil temperature at drain plug in the engine oil, the transmission at the end of the dip stick, and the differential in the lubricant at the filler plug. The thermocouple placement was intended to obtain meaningful relative data during vehicle warm-up and not necessarily accurate as representative component temperatures.

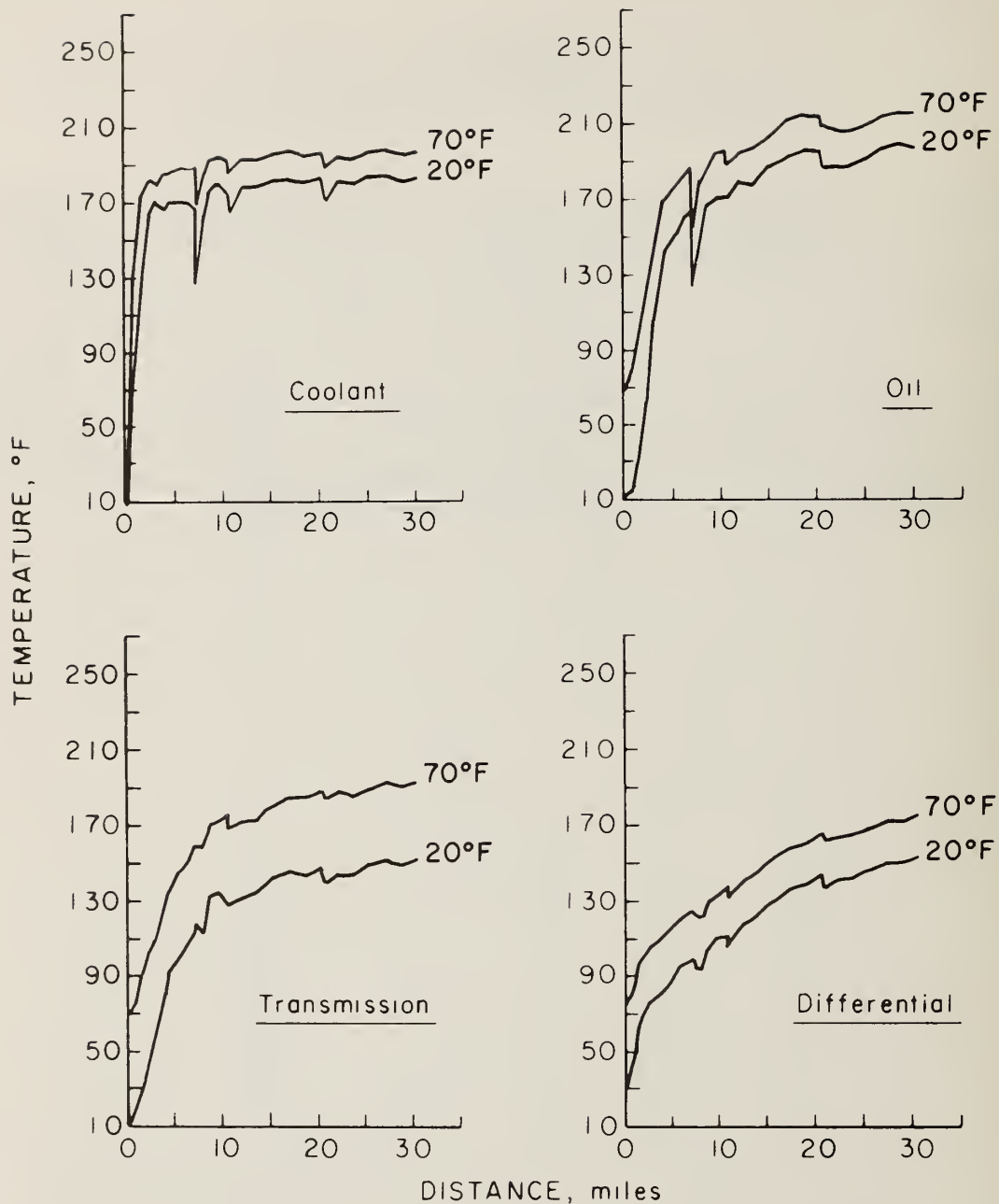


FIGURE E-1. - Vehicle Temperatures and Distance Traveled During Cycle Operation from a Cold Start-- Vehicle 156.

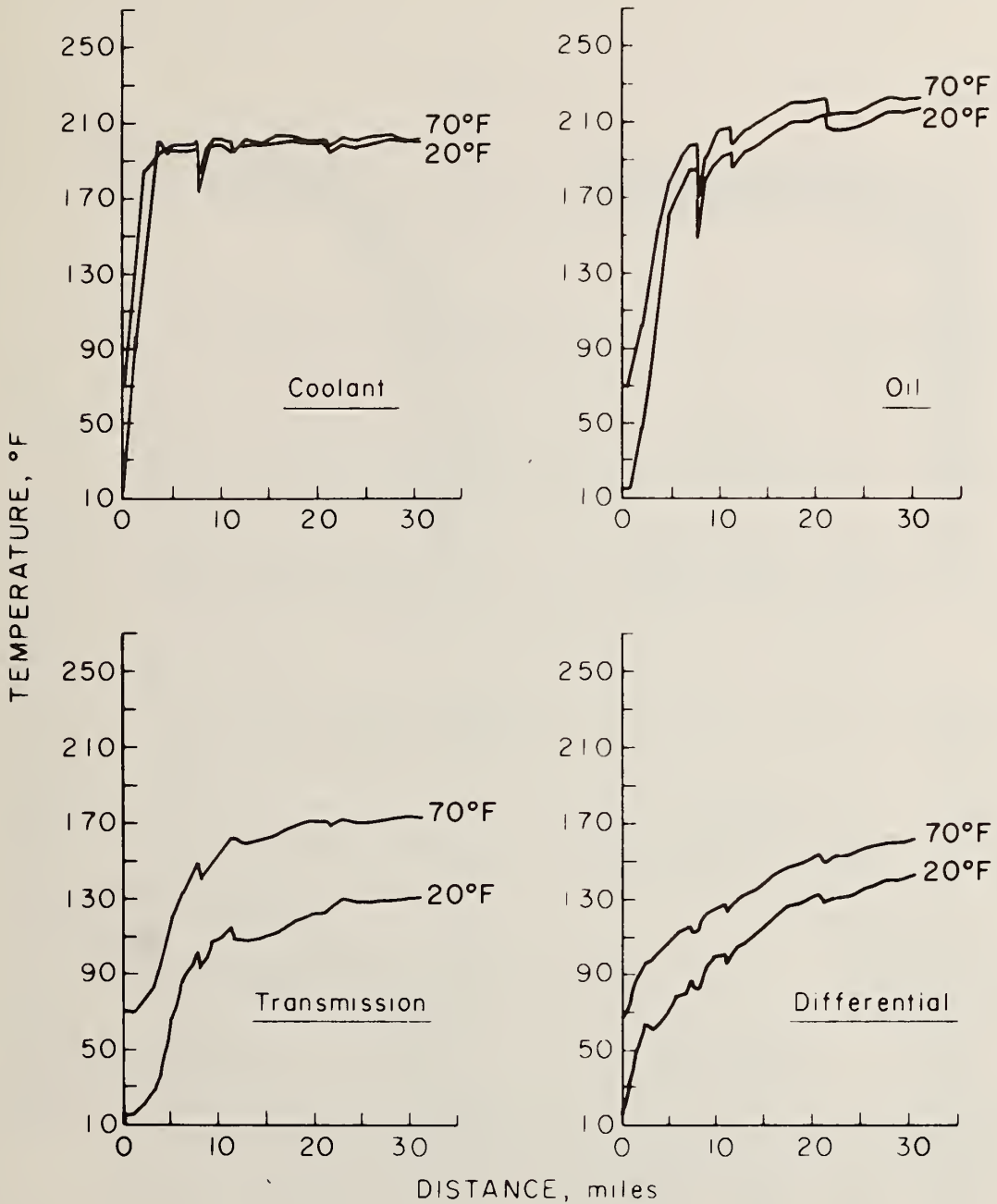


FIGURE E-2. - Vehicle Temperatures and Distance Traveled During Cycle Operation from a Cold Start-- Vehicle 157.

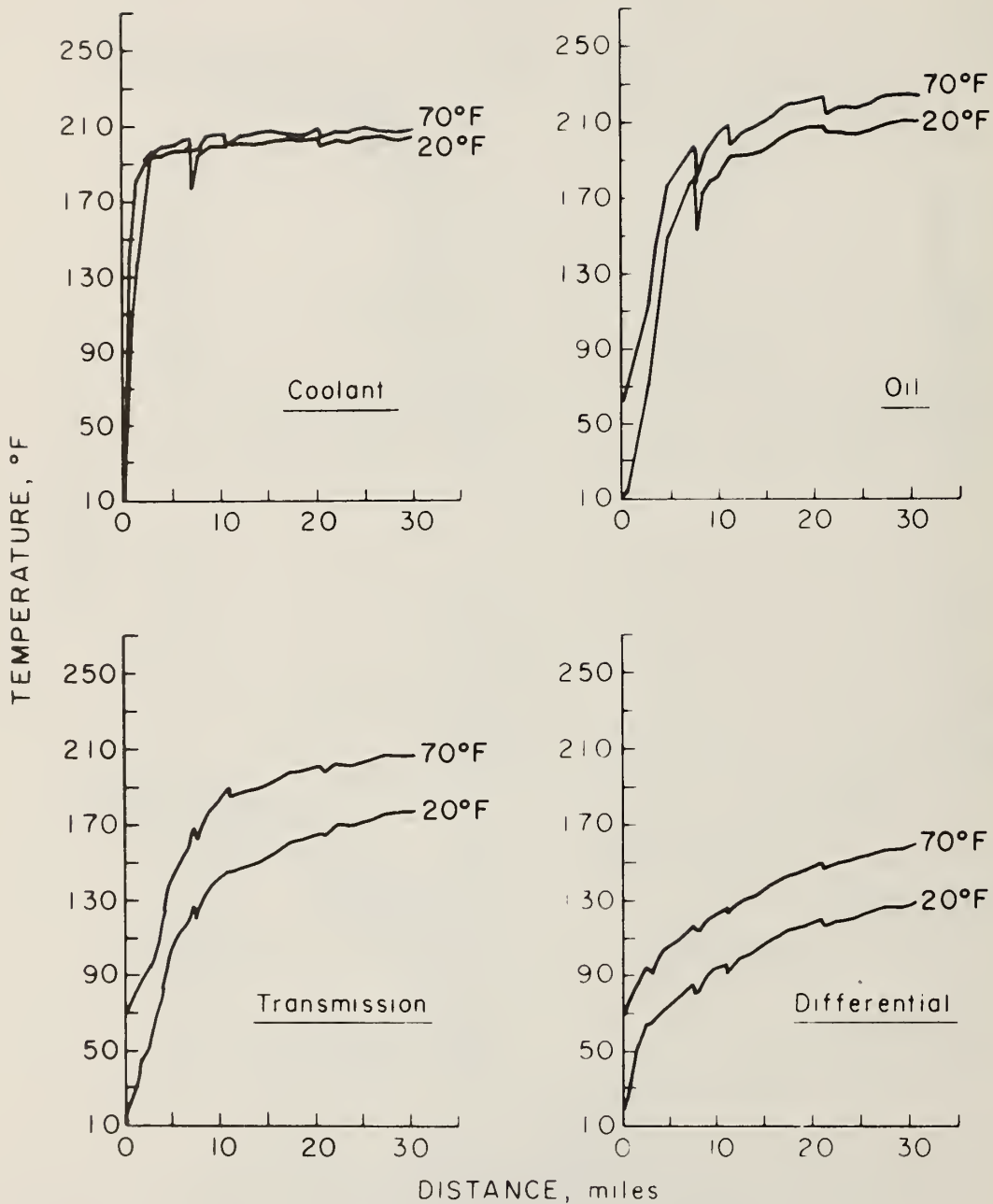


FIGURE E-3. - Vehicle Temperatures and Distance Traveled During Cycle Operation from a Cold Start-- Vehicle 158.



TABLE E-1. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle 156 at 20° F ambient with air conditioner off

	Time min.	Dist. miles	Temperature, deg. F				Trans.	Diff.
			Air to veh.	Air to Carb.	Coolant	Gil		
CT	0.0	0.0	12	12	12	12	13	11
	1.0	0.2	13	38	34	12	13	26
	3.0	0.8	13	75	89	14	21	43
	4.0	1.5	15	85	129	30	31	62
	5.0	2.4	16	108	163	62	49	75
S	7.0	3.1	16	122	169	103	62	78
	10.0	4.0	16	75	165	128	81	83
	12.0	4.4	16	64	168	141	91	86
	15.0	5.6	18	128	169	149	100	94
	19.0	6.7	18	95	168	159	108	98
HT	22.0	7.3	17	106	164	162	114	100
	24.0	7.5	14	93	125	124	118	94
	30.0	8.2	14	67	161	149	113	94
	37.0	8.9	17	107	174	164	132	104
	39.0	9.8	18	109	178	167	134	110
HWFE-1	41.0	10.9	18	113	173	168	127	111
	49.0	11.0	18	111	162	167	128	107
	51.0	12.4	20	103	176	175	131	117
	53.0	13.9	21	73	176	174	134	122
	55.0	15.5	23	124	179	183	141	129
HWFE-2	57.0	17.3	25	130	179	188	144	136
	59.0	19.1	25	105	178	191	143	139
	61.0	20.9	26	112	180	192	147	143
	63.0	21.3	24	60	169	183	139	137
	67.0	22.6	26	102	179	184	143	141
HWFE-2	69.0	24.1	26	79	177	194	143	142
	71.0	25.7	27	126	180	187	148	145
	73.0	27.6	28	117	181	192	150	145
	75.0	29.4	29	103	179	195	148	150
	77.0	31.1	29	123	180	193	151	153

TABLE E-2. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle 156 at 45° F ambient with air conditioner off

Time min.	Dist. miles	Air to Air to		temperature, deg. F		Trans.	Diff.
		veg.	carb.	Coolant	oil		
0.0	0.0	44	44	45	44	45	43
1.0	0.2	46	54	52	41	46	50
3.0	0.3	46	101	111	57	52	62
4.0	1.5	46	110	149	70	61	81
5.0	2.4	47	122	170	83	74	91
7.0	3.1	46	57	171	125	87	92
10.0	4.0	47	60	172	145	105	97
12.0	4.4	46	61	171	151	112	99
13.0	5.0	47	107	174	162	122	106
15.0	6.7	46	59	172	170	129	109
22.0	7.3	40	82	171	172	135	111
33.0	7.5	44	109	144	137	130	107
36.0	8.2	45	97	172	164	135	104
37.0	9.0	47	71	161	173	139	115
39.0	8.1	43	71	172	163	120	110
41.0	10.9	45	62	177	131	153	121
42.0	11.2	47	66	175	175	140	116
43.0	12.4	43	72	183	141	149	126
50.0	13.3	47	51	182	195	151	131
52.0	15.5	43	52	184	1	157	13
57.0	17.0	43	62	185	130	162	146
58.0	17.1	43	16	183	201	141	14
61.0	20.2	40	42	184	200	164	153
63.0	21.3	46	37	173	192	158	147
67.0	22.0	43	63	181	183	144	150
68.0	24.1	40	46	183	191	161	152
71.0	25.7	47	92	180	143	165	155
73.0	27.0	42	30	187	200	167	159
75.0	28.3	43	65	187	201	166	157
77.0	31.1	41	43	187	200	154	150

TABLE E-3. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle 156 at 70° F ambient with air conditioner off

Time min.	Dist. miles	Temperature, deg. F					
		Air to Veh.	Air to Carb.	Coolant	Oil	Trans.	Diff.
0.0	0.0	69	69	69	69	69	69
1.0	0.2	70	81	84	69	70	73
3.0	0.8	71	74	134	78	75	81
4.0	1.5	71	73	172	96	91	96
5.0	2.4	71	78	179	123	103	104
7.0	3.1	71	79	178	142	109	107
10.0	4.0	71	82	184	160	125	111
12.0	4.4	71	83	184	167	133	113
15.0	5.6	72	81	186	174	145	119
19.0	6.7	72	83	186	181	153	123
22.0	7.3	72	86	187	184	159	125
33.0	7.5	70	131	167	153	158	122
36.0	8.2	71	84	183	176	158	121
37.0	8.9	72	79	191	183	169	129
38.0	9.8	73	80	192	191	172	132
41.0	10.9	71	82	190	192	175	137
49.0	11.0	73	90	184	185	168	132
51.0	12.4	73	80	191	191	170	139
53.0	13.9	73	80	191	194	172	144
55.0	15.5	73	81	193	199	179	151
57.0	17.3	74	82	194	208	184	157
59.0	19.1	74	83	193	211	185	160
61.0	20.9	74	83	194	210	187	165
65.0	21.3	72	95	187	205	184	161
67.0	22.6	72	81	192	203	186	163
69.0	24.1	73	80	191	203	185	165
71.0	25.7	73	81	193	205	188	167
73.0	27.6	73	82	195	210	191	171
75.0	29.4	74	83	193	212	190	172
77.0	31.1	74	82	194	212	191	174

TABLE E-4. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average Vehicle 156 at 100° F ambient with air conditioner on

Time min.	Dist. miles	Temperature, deg. F							Trans.	Diff.
		Air to veh.	Air to Carb.	Coolant	Oil					
0.0	0.0	98	98	98	98	98	98	98	98	98
1.0	0.2	99	100	108	98	98	98	99	99	101
3.0	0.8	101	105	157	112	112	112	105	105	107
4.0	1.5	100	105	185	132	132	132	124	124	116
5.0	2.4	102	107	191	152	152	152	133	133	123
7.0	3.1	101	113	190	166	166	166	139	139	127
10.0	4.0	101	116	193	182	182	182	156	156	131
12.0	4.4	101	119	195	188	188	188	166	166	134
15.0	5.6	101	114	195	196	196	196	180	180	139
19.0	6.7	101	117	198	201	201	201	188	188	143
22.0	7.3	102	122	198	205	205	205	194	194	145
33.0	7.5	97	171	197	175	175	175	192	192	143
36.0	8.2	98	119	195	196	196	196	192	192	142
37.0	8.9	100	119	195	198	198	198	192	192	143
38.0	9.8	102	117	197	200	200	200	196	196	145
41.0	10.9	101	116	199	210	210	210	203	203	153
49.0	11.0	101	122	199	209	209	209	205	205	154
51.0	12.4	102	119	198	211	211	211	205	205	156
53.0	13.9	102	114	198	213	213	213	207	207	161
55.0	15.5	102	114	199	216	216	216	208	208	165
57.0	17.3	103	114	202	222	222	222	211	211	171
59.0	19.1	103	114	202	226	226	226	213	213	176
61.0	20.9	103	115	203	227	227	227	213	213	179
65.0	21.3	102	123	204	224	224	224	214	214	180
67.0	22.6	103	115	202	223	223	223	214	214	181
69.0	24.1	102	114	201	223	223	223	213	213	183
71.0	25.7	103	115	202	224	224	224	214	214	186
73.0	27.6	103	115	203	228	228	228	216	216	188
75.0	29.4	104	115	204	230	230	230	216	216	191
77.0	31.1	103	114	203	229	229	229	216	216	192

TABLE E-5. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
Vehicle 157 at 20° F ambient with air conditioner off

Time min.	Dist. miles	Air to veh.	Air to Carr.	Temperature, Cec.	Coelent Oil	Trans.	Diff.
0.0	0.0	12	14	18	15	16	15
1.0	0.2	13	23	44	15	15	19
3.0	0.8	14	43	101	28	18	34
4.0	1.5	15	30	139	48	22	50
5.0	2.4	17	73	173	78	26	63
7.0	3.1	17	74	200	106	36	61
10.0	4.0	18	124	193	142	53	65
12.0	4.4	19	90	195	157	66	68
15.0	5.6	20	64	195	172	85	78
19.0	6.7	21	133	195	182	95	80
22.0	7.3	22	84	196	183	102	86
33.0	7.5	16	91	173	146	92	82
36.0	8.2	18	53	192	177	99	82
37.0	8.9	21	25	197	163	107	93
38.0	9.8	23	123	198	188	110	99
41.0	10.9	23	133	195	192	115	100
45.0	11.0	22	67	194	183	109	95
51.0	12.4	24	78	198	191	108	104
53.0	13.9	25	98	197	196	109	109
55.0	15.5	27	121	199	202	112	117
57.0	17.3	29	74	200	208	117	123
59.0	19.1	30	61	199	208	120	127
61.0	20.9	31	64	199	212	122	131
65.0	21.3	31	62	194	204	124	127
67.0	22.6	31	111	198	204	129	129
69.0	24.1	31	85	196	205	128	130
71.0	25.7	32	89	198	209	128	134
73.0	27.6	33	63	200	213	129	138
75.0	29.4	34	67	199	213	130	139
77.0	31.1	35	66	200	215	131	142

TABLE E-6. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
Vehicle 157 at 45° F ambient with air conditioner off

Time min.	List. miles	Temperature, deg. F						
		Air to Veh.	Air to Cabl.	Coolant	Oil	Trans.	Diff.	
0.0	0.0	43	44	47	44	45	43	
1.0	0.2	45	54	73	45	45	46	
3.0	0.8	46	71	127	63	47	56	
4.0	1.5	47	49	165	81	51	67	
5.0	2.4	46	106	199	105	57	78	
7.0	3.1	45	64	192	135	68	79	
10.0	4.0	47	62	194	161	88	86	
12.0	4.3	45	66	196	169	96	87	
15.0	5.6	47	62	196	181	112	96	
19.0	6.7	47	55	196	189	119	100	
22.0	7.3	46	68	197	190	126	102	
33.0	7.5	44	105	175	155	118	95	
35.0	8.2	46	60	193	184	125	97	
37.0	8.9	48	52	199	181	131	105	
38.0	9.6	48	96	195	196	135	100	
41.0	10.5	46	55	197	198	140	112	
43.0	11.0	47	60	194	189	135	100	
44.0	12.4	47	57	194	187	140	112	
45.0	13.3	46	76	198	200	135	119	
46.0	15.5	46	62	194	205	136	120	
47.0	17.3	49	73	200	211	141	132	
48.0	18.1	45	57	199	210	145	135	
49.0	20.0	45	57	195	213	145	135	
50.0	21.3	46	65	195	204	145	135	
51.0	22.6	46	78	195	205	145	137	
52.0	24.1	46	66	197	205	146	138	
54.0	25.7	49	85	195	210	146	142	
55.0	27.6	45	64	200	214	148	145	
56.0	29.4	49	57	196	213	150	146	
57.0	31.1	49	57	198	215	150	148	

TABLE E-7. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle 157 at 70° F ambient with air conditioner off

Time min.	List. miles	Air to		Temperature, deg. F				
		Ver.	Air to Cart.	Coculant	Oil	Trans.	Liff.	
0.0	0.0	69	70	72	70	70	67	
1.0	0.2	71	74	95	70	70	68	
3.0	0.6	71	74	147	85	72	74	
4.0	1.5	71	72	183	101	77	87	
5.0	2.4	72	76	188	127	82	95	
7.0	3.1	71	78	194	151	93	97	
10.0	4.0	71	82	196	171	111	102	
12.0	4.4	71	86	198	177	120	104	
15.0	5.6	72	80	198	189	134	110	
19.0	6.7	71	82	198	195	141	114	
22.0	7.3	71	92	200	195	148	116	
33.0	7.5	70	128	184	167	138	111	
36.0	8.2	70	92	196	190	145	113	
37.0	8.9	72	77	201	197	150	119	
38.0	9.8	73	77	201	203	155	123	
41.0	10.9	71	80	199	205	162	126	
49.0	11.0	71	105	195	195	160	122	
51.0	12.4	73	77	201	203	159	129	
53.0	13.9	71	75	199	207	161	133	
55.0	15.5	73	77	202	212	163	139	
57.0	17.3	72	76	202	217	167	145	
59.0	19.1	72	76	200	218	170	148	
61.0	20.9	72	77	201	220	171	152	
65.0	21.3	71	106	197	210	169	148	
67.0	22.6	73	77	201	212	171	151	
69.0	24.1	72	75	200	213	170	152	
71.0	25.7	74	77	201	216	170	155	
73.0	27.6	72	76	202	220	172	158	
75.0	29.4	72	76	201	220	173	159	
77.0	31.1	73	77	201	221	173	161	



TABLE E-8. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average Vehicle 157 at 100° F ambient with air conditioner on

Time min.	Dist. miles	Temperature, deg. F						
		Air to Veh.	Air to Carb.	Coolant	Oil	Trans.	Diff.	
0.0	0.0	98	100	102	100	100	99	
1.0	0.2	100	102	123	100	100	101	
3.0	0.8	100	103	170	115	104	105	
4.0	1.5	101	102	198	136	109	113	
5.0	2.4	102	105	201	157	115	119	
7.0	3.1	100	108	204	173	130	122	
10.0	4.0	100	114	203	188	150	126	
12.0	4.4	101	116	206	194	160	128	
15.0	5.6	101	111	203	202	172	133	
19.0	6.7	101	113	205	205	176	137	
22.0	7.3	102	120	208	205	182	138	
33.0	7.5	101	165	225	183	172	136	
36.0	8.2	99	132	203	200	177	137	
37.0	8.5	99	112	201	205	179	137	
39.0	9.0	102	112	204	208	197	141	
41.0	10.0	101	114	207	213	188	146	
42.0	11.0	102	120	205	211	191	146	
51.0	12.4	102	119	202	215	192	150	
53.0	13.9	103	109	202	216	191	155	
55.0	15.5	104	109	204	220	191	159	
57.0	17.3	103	109	204	224	192	164	
59.0	19.1	102	108	202	225	192	168	
61.0	20.9	102	112	204	223	190	171	
65.0	21.3	102	113	205	220	190	170	
67.0	22.2	103	109	202	219	191	172	
69.0	24.1	103	109	203	220	190	172	
71.0	25.7	103	108	203	223	190	176	
73.0	27.6	103	108	204	225	191	179	
75.0	29.4	102	113	204	225	190	180	

TABLE E-9. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average Vehicle T58 at 20° F ambient with air conditioner off

Time min.	Dist. miles	Temperature, deg. F				Coolant oil	Trans.	Wtft.
		Air to	Carb.	Air to	Oil			
0.0	0.0	12	14	17	15	15	14	
1.0	0.2	13	30	45	17	15	13	
2.0	0.3	14	69	103	20	25	35	
3.0	1.5	15	84	130	47	42	52	
4.0	2.4	15	105	159	70	52	63	
5.0	3.1	16	94	133	93	65	65	
6.0	4.0	17	115	193	132	83	70	
7.0	4.4	17	103	194	147	97	71	
8.0	5.0	18	102	196	152	111	77	
9.0	6.7	19	108	196	175	110	82	
10.0	7.3	19	105	199	180	125	84	
11.0	7.5	14	33	175	151	120	80	
12.0	8.2	15	95	193	170	129	81	
13.0	8.9	19	110	195	177	134	88	
14.0	9.3	21	103	198	181	139	93	
15.0	10.9	21	149	138	139	144	94	
16.0	11.0	20	110	199	191	144	91	
17.0	12.4	22	98	199	191	146	98	
18.0	13.9	24	113	199	193	148	102	
19.0	15.5	25	89	200	197	152	107	
20.0	17.3	27	89	201	202	153	112	
21.0	19.1	28	71	201	205	161	115	
22.0	20.9	30	74	202	206	164	118	
23.0	21.3	27	77	198	204	164	115	
24.0	22.6	29	85	200	203	168	117	
25.0	24.1	30	108	199	202	168	118	
26.0	25.7	31	83	201	204	170	121	
27.0	27.6	32	75	202	207	174	124	
28.0	29.4	33	61	200	209	175	125	
29.0	31.1	33	67	202	209	176	127	

TABLE E-10. Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle 158 at 45° F ambient with air conditioner off

Time min.	List. miles	Air to		Temperature, deg. F			
		Veh.	Carb.	Coilant	Oil	Trans.	Liff.
0.0	0.0	44	46	48	46	48	44
1.0	0.2	46	65	72	47	48	47
3.0	0.8	47	96	125	64	56	57
4.0	1.5	46	113	159	77	67	68
5.0	2.4	48	110	185	100	79	77
7.0	3.1	49	104	193	122	90	80
10.0	4.0	47	85	194	151	109	84
12.0	4.4	46	94	195	164	119	86
15.0	5.6	48	86	197	173	130	91
19.0	6.7	47	91	198	185	142	96
22.0	7.3	47	86	200	189	152	98
33.0	7.5	42	107	183	158	146	94
36.0	8.2	45	99	194	181	155	93
37.0	8.9	48	86	199	188	160	99
38.0	9.8	48	77	200	192	164	103
41.0	10.9	47	108	200	198	170	105
45.0	11.0	48	84	198	192	168	103
51.0	12.4	48	80	200	198	170	109
53.0	13.9	48	92	200	201	172	113
55.0	15.5	49	68	202	204	175	118
57.0	17.3	50	64	203	210	180	123
59.0	19.1	49	62	202	212	182	126
61.0	20.9	49	69	204	214	185	129
65.0	21.3	46	85	199	209	184	127
67.0	22.0	45	67	201	210	186	129
69.0	24.1	49	93	201	209	186	130
71.0	25.7	50	68	204	210	187	132
73.0	27.6	50	64	204	214	191	135
75.0	29.4	49	65	202	215	191	136
77.0	31.1	49	69	204	217	192	139

TABLE E-11. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
Vehicle 158 at 70° ambient with air conditioner off

Time min.	Dist. miles	Air to Air to		Temperature, deg. F					Trans.	Diff.
		Veh.	Carb.	Coolant	Oil	Trans.	Diff.			
0.0	0.0	68	69	70	69	69	67			
1.0	0.2	70	89	95	70	70	69			
3.0	0.8	70	111	143	85	77	76			
4.0	1.5	70	86	180	97	85	85			
5.0	2.4	72	87	190	113	94	93			
7.0	3.1	71	93	195	142	105	90			
10.0	4.0	70	93	198	166	123	101			
12.0	4.4	70	94	198	176	134	103			
15.0	5.6	71	87	199	185	147	108			
19.0	6.7	70	90	202	194	157	113			
22.0	7.3	71	95	202	197	167	115			
33.0	7.5	69	121	195	174	162	113			
36.0	8.2	70	91	196	191	169	113			
37.0	8.9	72	83	202	198	176	118			
38.0	9.8	73	86	204	202	180	121			
41.0	10.9	70	88	204	207	188	124			
49.0	11.0	72	97	198	197	184	122			
51.0	12.4	73	82	203	203	186	128			
53.0	13.9	74	90	204	207	187	131			
55.0	15.5	74	83	205	211	191	136			
57.0	17.3	74	83	205	218	196	140			
59.0	19.1	74	83	203	219	197	144			
61.0	20.9	74	83	205	221	199	147			
65.0	21.3	71	98	202	213	198	145			
67.0	22.6	73	82	204	216	201	147			
69.0	24.1	74	86	205	216	200	149			
71.0	25.7	75	84	206	217	202	151			
73.0	27.6	73	83	205	222	205	154			
75.0	29.4	75	83	204	222	205	155			
77.0	31.1	74	82	205	223	205	158			

TABLE E-12. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle 158 at 100° F Ambient with air conditioner on

Time min.	Dist. miles	Temperature, deg. F							Trans.	Diff.
		Air to veh.	Air to Carb.	Coolant	Oil					
0.0	0.0	98	99	100	99	100	99	100	100	
1.0	0.2	99	104	112	101	104	101	100	101	
3.0	0.8	99	106	137	110	104	110	104	104	
4.0	1.5	100	105	147	116	109	116	109	106	
5.0	2.4	101	107	152	132	116	132	116	109	
7.0	3.1	101	115	171	147	122	147	122	114	
10.0	4.0	101	123	203	169	143	169	143	122	
12.0	4.4	101	125	208	184	154	184	154	125	
15.0	5.6	102	125	209	197	169	197	169	129	
19.0	6.7	101	127	210	206	181	206	181	134	
22.0	7.3	102	129	210	209	189	209	189	138	
33.0	7.5	100	162	198	190	190	190	190	140	
36.0	8.2	98	145	202	201	191	201	191	140	
37.0	8.9	99	139	199	200	193	200	193	141	
38.0	9.8	101	139	197	202	193	202	193	143	
41.0	10.9	100	132	212	215	201	215	201	147	
49.0	11.0	101	141	211	216	210	216	210	156	
51.0	12.4	103	129	211	218	210	218	210	155	
53.0	13.9	102	125	212	220	212	220	212	156	
55.0	15.5	103	125	211	221	212	221	212	160	
57.0	17.3	104	118	216	227	215	227	215	165	
58.0	19.1	104	118	218	232	221	232	221	165	
61.0	20.9	104	120	215	234	218	234	218	170	
65.0	21.3	103	133	220	236	221	236	221	186	
67.0	22.6	104	119	216	236	221	236	221	185	
69.0	24.1	104	123	218	234	221	234	221	185	
71.0	25.7	104	126	218	235	222	235	222	182	
73.0	27.6	105	124	219	238	224	238	224	187	
75.0	29.4	104	120	216	239	224	239	224	186	
77.0	31.1	104	118	217	238	224	238	224	180	

TABLE E-13. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle 159 at 20° F ambient with air conditioner off

Time min.	Dist. miles	Temperature, deg. F					
		Air to veh.	Air to carb.	Coolant	Oil	Trans.	
0.0	0.0	12	12	15	13	13	11
1.0	0.1	14	28	47	14	13	18
3.0	0.8	13	56	110	21	16	39
4.0	1.5	14	66	154	41	24	51
5.0	2.4	15	84	191	61	32	65
7.0	3.1	15	94	211	79	40	67
10.0	4.0	16	117	191	108	63	73
12.0	4.4	16	117	192	120	76	75
15.0	5.6	18	116	199	131	95	82
19.0	6.7	18	117	195	144	106	86
22.0	7.3	18	120	200	149	117	89
33.0	7.5	15	68	174	120	119	83
36.0	8.2	14	92	209	140	120	85
37.0	8.9	17	99	196	145	122	92
38.0	9.8	19	113	194	149	126	97
41.0	10.9	19	125	196	159	133	99
43.0	11.0	19	103	199	150	130	92
51.0	12.4	21	106	199	156	130	99
53.0	13.9	22	117	191	161	130	104
55.0	15.5	24	120	197	168	131	109
57.0	17.3	25	123	196	178	135	115
59.0	19.1	26	128	194	182	138	116
61.0	20.9	27	123	196	184	139	122
65.0	21.3	24	132	191	180	140	117
67.0	22.6	27	122	197	178	142	119
69.0	24.1	28	124	195	178	141	120
71.0	25.7	28	122	197	179	141	123
73.0	27.6	30	125	196	194	143	126
75.0	29.4	31	130	195	186	145	126
77.0	31.1	31	126	196	187	145	129

TABLE E-14. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle T59 at 45° F ambient with air conditioner off

Time Min.	Dist. Miles	Temperature, °C. F.					Trans.	Liff.
		Air to veh.	Air to Carb.	Coolant	Oil			
0.0	0.0	45	45	48	46	48	44	
1.0	0.2	45	60	74	46	48	48	
3.0	0.8	47	85	131	54	50	58	
4.0	1.5	47	96	174	68	57	72	
5.0	2.4	47	113	210	86	65	83	
7.0	3.1	46	119	191	103	73	84	
10.0	4.0	47	126	190	122	95	88	
12.0	4.4	47	131	192	136	105	91	
15.0	5.6	48	134	193	144	119	96	
19.0	6.7	48	137	193	155	127	101	
22.0	7.3	48	135	195	161	134	104	
33.0	7.5	46	113	189	149	135	102	
36.0	8.2	45	112	190	153	137	102	
37.0	8.9	47	121	196	160	140	107	
38.0	9.8	49	131	196	164	149	111	
41.0	10.9	48	130	195	170	145	114	
49.0	11.0	47	130	194	173	145	112	
51.0	12.4	49	125	196	173	146	116	
53.0	13.9	48	135	186	176	147	119	
55.0	15.5	49	138	198	180	149	124	
57.0	17.3	50	154	199	187	152	128	
59.0	19.1	50	154	197	189	155	130	
61.0	20.9	50	149	198	190	157	133	
65.0	21.3	47	136	193	190	156	131	
67.0	22.6	50	147	197	189	160	132	
69.0	24.1	49	148	196	188	159	133	
71.0	25.7	50	147	199	190	159	135	
73.0	27.6	50	157	200	194	161	13	
75.0	29.4	50	155	198	194	162	136	
77.0	31.1	50	151	199	195	162	140	



TABLE E-15. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle 159 at 70° F ambient with air conditioner off

Time min.	Dist. miles	Air to Air to		Temperature, deg. F				Trans.	Diff.
		Veh.	Carb.	Coolant	Oil				
0.0	0.0	69	69	70	69	70	69	70	69
1.0	0.2	70	79	86	69	70	69	70	71
3.0	0.8	71	95	124	75	71	75	71	76
4.0	1.5	70	98	153	82	75	82	75	82
5.0	2.4	71	113	154	94	80	94	80	87
7.0	3.1	70	103	154	107	88	107	88	90
10.0	4.0	70	99	166	120	101	120	101	94
12.0	4.4	71	95	187	129	110	129	110	99
15.0	5.6	72	124	197	148	125	148	125	108
19.0	6.7	70	117	197	161	138	161	138	112
22.0	7.3	72	109	198	169	148	169	148	116
33.0	7.5	69	117	203	158	156	158	156	117
39.0	8.2	70	105	202	167	158	167	158	117
37.0	8.9	72	130	207	169	160	169	160	120
36.0	9.8	72	127	208	171	161	171	161	122
41.0	10.9	71	112	207	175	165	175	165	124
49.0	11.0	72	106	196	184	166	184	166	126
51.0	12.4	72	124	199	186	168	186	168	129
53.0	13.9	73	126	198	188	168	188	168	131
55.0	15.5	73	126	202	191	169	191	169	133
57.0	17.3	73	127	203	195	173	195	173	138
59.0	18.1	73	114	203	197	174	197	174	140
61.0	20.9	73	130	204	200	176	200	176	144
65.0	21.3	72	110	201	204	178	204	178	145
67.0	22.6	74	119	203	201	180	201	180	146
69.0	24.1	72	127	201	202	179	202	179	147
71.0	25.7	73	132	204	203	180	203	180	149
75.0	27.6	74	110	204	204	181	204	181	151
75.0	29.4	73	106	202	204	181	204	181	151
77.0	31.1	73	128	206	208	182	208	182	154

TABLE E-16. - Time, distance, and temperatures during 31 miles of cyclic operation on a dynamometer, 3 replicate average  
 Vehicle 159 at 100° F ambient with air conditioner on

Time min.	Dist. Miles	Temperature, deg. F							Diff.
		Air to Veh.	Air to Carb.	Oil	Trans.	Diff.			
0.0	0.0	98	98	99	99	99	99	99	99
1.0	0.2	101	107	124	99	99	99	100	100
3.0	0.8	99	107	180	109	103	103	105	105
4.0	1.5	100	107	208	120	106	106	112	112
5.0	2.4	101	112	206	130	119	119	117	117
7.0	3.1	100	122	208	155	129	129	121	121
10.0	4.0	100	124	206	169	149	149	126	126
12.0	4.4	100	125	208	177	159	159	129	129
15.0	5.0	101	118	205	164	170	170	133	133
19.0	6.7	100	122	208	193	179	179	137	137
22.0	7.3	101	127	208	197	187	187	140	140
33.0	7.5	100	153	233	175	183	183	139	139
36.0	8.2	99	125	204	192	187	187	139	139
37.0	8.9	100	129	204	193	188	188	140	140
38.0	9.8	103	122	206	197	190	190	144	144
41.0	10.9	101	122	209	203	195	195	148	148
49.0	11.0	101	127	205	205	197	197	150	150
51.0	12.4	102	119	205	206	198	198	153	153
53.0	13.9	102	118	206	208	197	197	156	156
55.0	15.5	102	120	207	213	199	199	161	161
57.0	17.3	103	120	207	218	201	201	164	164
59.0	19.1	102	119	206	222	202	202	167	167
61.0	20.9	102	122	208	221	201	201	168	168
65.0	21.3	101	124	208	219	202	202	169	169
67.0	22.6	102	119	205	219	204	204	170	170
69.0	24.1	102	120	206	219	202	202	172	172
71.0	25.7	103	120	208	222	203	203	174	174
73.0	27.0	103	120	207	224	204	204	176	176
75.0	29.4	103	120	207	224	204	204	176	176
77.0	31.1	101	128	217	218	203	203	176	176

APPENDIX F  
STEADY-STATE TEMPERATURE, TORQUE, AND FUEL

Appendix F contains tables listing data collected during steady-state tests of vehicles 156 and 158 at 20°, 45°, 70°, and 100° F driven at speeds of 30, 45, and 60 mph. The vehicles were soaked at the test temperature for 12 hours, pushed into the dynamometer, started cold, accelerated rapidly to the test speed, and driven at constant speed for 60 minutes at 30 and 45 mph and for 45 minutes at 60 mph. Data were collected at one-minute intervals to nine minutes then at 3-minute intervals to end of test. Dynamometer horsepower was the indicated horsepower read from the dynamometer indicating meter and drive-shaft torque was sensed by an inline torque meter with readings taken from a digital meter. Fuel consumption was obtained from carbon balance calculations made from continuous analysis of the dilute exhaust stream and computer interpretation. Readings of drive shaft torque were changing rapidly during the first reading at 0.3 minute and were not reliable. In addition, several readings were missed and a zero in this column should be interpreted as no reading.

TABLE F-1. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 156 at 20° F ambient and 30 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dyno h.p.	Temperature, deg. F		Diff.
					Air to veh.	Coolant Oil	
0.3	-	-	-	-	20	23	16
1.0	0.4	6.7	15	1.3	16	48	17
2.0	0.9	9.9	15	1.7	16	70	17
3.0	1.4	11.0	11	1.1	16	87	21
4.0	1.8	12.4	15	1.7	16	97	27
5.0	2.3	13.3	-	-	16	109	35
6.0	2.7	14.8	-	-	17	122	42
7.5	3.3	15.8	-	-	16	126	49
8.0	3.6	16.3	13	1.4	17	121	57
9.0	4.1	17.1	13	1.6	18	107	60
12.0	5.6	19.0	15	0.9	18	57	65
15.0	7.1	20.3	12	1.6	19	94	81
16.0	8.6	21.4	12	1.7	20	113	88
21.0	10.1	22.3	12	1.7	21	104	95
24.0	11.6	23.6	11	1.6	21	57	103
27.0	13.1	23.9	11	1.6	22	101	107
30.0	14.6	24.1	11	1.6	22	100	110
33.0	16.1	24.6	-	-	22	101	113
36.0	17.6	24.7	11	1.6	23	123	114
39.0	19.1	25.3	11	1.6	23	124	115
42.0	20.6	25.6	11	1.6	23	101	117
45.0	22.1	25.9	11	1.6	23	51	118
48.0	23.6	26.1	11	1.7	23	79	119
51.0	25.1	26.3	11	1.6	24	120	120
54.0	26.6	26.5	11	1.7	24	116	121
57.0	28.1	26.7	11	1.6	24	102	122
60.0	29.6	26.9	-	-	24	59	123

TABLE F-2. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 156 at 20° F ambient and 45 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dync h.p.	Temperature, deg. F				Trans.	Diff.
					Air to Veh.	Air to Carb.	Coolant	Oil		
0.3	-	-	-	-	15	23	19	15	16	17
1.0	0.4	8.6	-	-	15	24	48	16	17	41
2.0	1.2	11.3	22	5.9	16	73	96	16	23	59
3.0	1.9	13.4	17	5.9	16	93	137	40	34	70
4.0	2.7	15.1	19	6.4	17	106	166	69	45	78
5.0	3.4	16.3	18	6.0	18	118	184	90	55	85
6.0	4.2	17.4	18	6.1	19	125	183	116	63	92
7.0	4.9	18.2	17	6.1	19	124	173	133	72	98
8.0	5.7	18.9	17	5.8	20	75	168	144	81	102
9.0	6.4	19.5	17	5.9	21	54	169	151	86	107
10.0	7.1	20.3	17	6.1	22	63	170	164	98	117
11.0	7.8	21.0	16	6.0	22	110	170	172	111	124
12.0	8.5	21.7	16	6.0	24	117	171	176	120	129
13.0	9.2	22.5	16	6.0	24	117	171	176	120	129
14.0	10.0	23.1	16	5.8	25	45	171	161	125	134
15.0	10.8	23.6	16	5.8	26	121	172	182	128	137
16.0	11.6	24.0	16	5.9	26	48	173	183	130	140
17.0	12.4	24.4	16	5.9	26	85	177	184	130	142
18.0	13.2	24.7	16	6.0	27	102	178	184	132	144
19.0	14.0	25.0	15	5.9	28	51	177	184	134	145
20.0	14.8	25.3	15	5.9	28	81	176	184	135	146
21.0	15.6	25.5	16	5.9	29	107	176	184	136	147
22.0	16.4	25.7	15	5.9	28	49	177	185	137	147
23.0	17.2	25.9	16	5.9	29	52	177	184	137	148
24.0	18.0	26.1	15	6.0	30	56	177	185	138	148
25.0	18.8	26.2	15	5.9	29	76	177	185	138	149
26.0	19.6	26.4	15	5.9	30	61	176	185	138	149
27.0	20.4	26.5	15	6.0	30	101	178	184	138	149
28.0	21.2	26.5	15	6.0	30	101	178	184	138	149

TABLE F-3. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start Vehicle 156 at 20° F ambient and 60 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dyno n.p.	Temperature, deg. F						Diff.
					Air to veh.	Air to Carb.	Coolant	Oil	Trans.		
0.5	-	5.1	-	-	12	16	13	13	13	14	
1.0	0.5	8.5	-	-	13	50	13	13	14	47	
2.0	1.5	10.6	28	14.6	15	81	15	15	25	66	
3.0	2.5	12.2	26	15.5	16	107	53	53	51	81	
4.0	3.5	13.4	25	14.3	17	120	100	100	70	93	
5.0	4.5	14.3	25	14.7	18	115	133	86	86	102	
6.0	5.5	15.1	24	13.8	20	45	148	100	100	109	
7.0	6.5	15.7	24	14.1	20	123	162	102	102	115	
8.0	7.5	16.2	24	14.2	21	48	172	113	113	120	
9.0	8.5	16.7	23	14.4	22	125	177	119	119	125	
12.0	11.5	17.8	24	14.4	24	43	178	132	132	136	
15.0	14.5	18.6	23	14.4	25	66	179	142	142	146	
18.0	17.5	19.2	23	14.2	27	122	179	149	149	152	
21.0	20.5	19.7	23	14.3	28	46	180	154	154	157	
24.0	23.5	20.0	23	14.2	29	100	179	157	157	162	
27.0	26.5	20.4	23	14.3	30	51	183	160	160	165	
30.0	29.5	20.7	23	14.2	31	85	183	163	163	168	
33.0	32.5	20.9	23	14.2	32	49	182	165	165	170	
36.0	35.5	21.1	23	14.1	32	124	181	166	166	172	
39.0	38.5	21.5	23	14.1	33	51	182	166	166	174	
40.0	39.5	21.4	23	14.1	33	99	182	167	167	174	



TABLE F-4. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 156 at 45° F ambient and 30 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Lyne h.p.	Temperature, deg. F				Trans.	Diff.
					Air to veh.	Air to Carb.	Coolant	Cil		
0.2	-	-	-	-	47	52	49	47	47	47
1.0	0.4	11.1	15	1.7	47	75	72	47	47	55
2.0	0.9	13.8	12	1.6	47	96	102	53	51	67
3.0	1.4	16.2	13	1.6	47	110	129	66	57	73
4.0	1.9	17.8	15	1.6	47	64	153	77	64	77
5.0	2.4	19.1	12	1.7	47	61	174	86	70	82
6.0	2.9	20.2	12	1.7	47	60	187	103	77	67
7.0	3.5	21.0	12	1.7	48	59	183	117	63	91
8.0	4.0	21.6	12	1.6	48	58	180	124	69	95
9.0	4.5	22.5	12	1.7	46	62	181	132	95	98
12.0	6.0	24.0	11	1.7	49	75	175	154	106	105
15.0	7.5	25.2	11	1.6	47	65	170	163	113	110
18.0	9.0	26.6	11	1.7	49	60	176	169	117	115
21.0	10.5	26.7	10	1.7	50	66	177	174	124	119
24.0	12.0	27.2	11	1.6	48	69	177	176	124	122
27.0	13.5	27.7	11	1.6	49	66	177	176	126	124
30.0	15.0	28.1	11	1.7	48	68	177	177	129	126
33.0	16.6	28.4	11	1.7	48	65	177	178	131	128
36.0	18.0	28.9	11	1.7	48	69	183	179	134	130
39.0	19.6	29.3	10	1.7	48	69	183	179	134	130
42.0	21.1	29.2	10	1.6	49	67	176	178	135	131
45.0	22.6	29.4	10	1.6	47	68	176	178	135	132
48.0	24.1	29.6	10	1.7	49	69	176	177	139	132
51.0	25.6	29.7	10	1.6	48	68	176	178	136	133
54.0	27.1	29.9	10	1.7	49	69	193	177	136	135
57.0	28.6	30.0	10	1.7	48	67	184	178	136	134
60.0	30.1	30.1	10	1.7	49	67	183	179	137	134



TABLE F-5. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start Vehicle 156 at 45° F ambient and 45 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Lyno n.p.	Temperature, deg. f		Trans.	Diff.
					Air to veh.	Coolant Oil		
0.3	-	-	-	-	52	47	46	48
1.0	0.6	12.4	32	6.0	77	80	46	64
2.0	1.3	15.6	16	5.8	104	122	63	76
3.0	2.1	17.7	15	6.1	72	156	82	85
4.0	2.2	19.2	17	6.1	92	185	100	93
5.0	3.6	20.3	17	6.2	103	175	120	99
6.0	4.3	21.1	17	6.0	59	175	137	104
7.0	5.1	21.8	16	6.1	62	177	149	109
8.0	5.8	22.4	16	6.2	92	179	156	114
9.0	6.0	22.9	16	6.0	69	178	163	117
12.0	6.9	24.1	16	6.2	69	179	177	126
13.0	11.1	24.9	16	6.1	69	179	184	134
16.0	13.4	25.4	16	6.1	68	180	188	139
21.0	15.7	25.9	15	6.0	49	180	190	143
24.0	17.9	26.3	15	6.2	67	184	192	147
27.0	20.2	26.6	15	6.0	67	184	190	150
30.0	22.5	26.9	15	6.1	66	184	193	152
33.0	24.3	27.0	-	-	78	185	192	155
36.0	27.0	27.3	16	5.6	64	184	192	155
39.0	29.2	27.5	15	6.0	65	183	193	157
42.0	31.5	27.6	15	6.0	66	184	191	157
45.0	33.8	27.8	15	6.0	67	184	193	158
48.0	36.0	27.9	15	6.0	67	184	192	159
51.0	38.3	28.1	15	6.0	67	183	193	159
54.0	40.5	28.2	15	6.0	67	183	192	159
57.0	42.8	28.3	15	6.0	65	184	192	159
60.0	45.0	28.4	16	6.0	66	184	193	160

TABLE F-6. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 156 at 45° F ambient and 60 mph

Time min.	Dist. miles	fuel gpc	Torque ft.-lb.	dyno n.p.	Temperature, deg. F						
					Air to Ven.	Air to Carb.	Coolant	Oil	Trans.	Luff.	
0.5	-	-	-	-	46	47	48	46	46	46	49
1.0	0.7	13.5	28	14.4	45	53	37	48	48	48	62
2.0	1.7	15.6	25	14.7	46	111	141	72	63	63	85
3.0	2.7	16.9	23	14.5	47	123	162	104	80	80	99
4.0	3.7	17.8	23	14.5	48	58	184	134	97	97	108
5.0	4.7	18.5	25	14.6	49	64	173	154	109	109	115
6.0	5.7	19.1	22	14.3	49	68	181	166	116	116	121
7.0	6.7	19.6	22	14.6	48	67	182	177	124	124	137
8.0	7.7	20.0	22	14.6	48	67	182	186	130	130	132
9.0	8.7	20.4	21	14.4	46	66	183	186	135	135	136
10.0	11.0	21.2	22	14.7	48	66	184	202	143	143	147
15.0	14.6	21.7	22	14.6	48	66	184	207	157	157	155
18.0	17.6	22.1	21	14.5	49	66	184	210	164	164	162
21.0	20.8	22.5	22	14.6	49	66	185	211	167	167	167
24.0	23.6	22.7	22	14.6	49	66	186	212	172	172	171
27.0	26.6	23.0	22	14.5	50	66	186	212	174	174	175
30.0	29.9	23.1	22	14.7	50	66	186	213	176	176	177
33.0	32.0	23.3	22	14.7	50	66	186	212	177	177	179
36.0	35.5	23.4	22	14.7	50	66	186	213	179	179	181
39.0	38.9	23.5	22	14.4	50	66	187	213	179	179	182
40.0	39.9	23.6	22	14.5	50	66	189	214	180	180	183

TABLE F-7. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 156 at 70° F ambient and 30 mph

Mile.	Dist. miles	Fuel mpg	Torque ft.lb.	Lyno h.p.	Temperature, deg. F		Coolant	Oil	Trans.	Lift.
					Air to veh.	Air to Corp.				
0.0	-	-	-	-	70	73	71	70	70	71
4.0	0.4	15.1	11	-	72	92	92	70	70	78
8.0	0.9	18.7	13	1.8	72	74	121	77	74	84
12.0	1.4	20.7	12	1.7	72	75	146	83	79	86
16.0	1.9	22.1	10	1.7	72	75	168	96	85	93
20.0	2.4	23.2	11	1.7	72	75	188	112	91	96
24.0	2.9	24.1	10	1.6	72	75	183	124	96	100
28.0	3.4	24.9	11	1.6	72	76	183	132	101	102
32.0	3.9	25.5	11	1.7	72	77	185	142	106	105
36.0	4.4	26.0	10	1.7	72	77	186	149	110	108
40.0	4.9	27.3	10	1.7	73	79	187	165	120	114
44.0	5.4	28.2	10	1.6	73	80	187	174	127	120
48.0	5.9	28.9	10	1.6	73	81	188	178	132	124
52.0	6.4	29.5	10	1.7	73	81	188	182	137	127
56.0	6.9	30.0	10	1.7	74	82	188	185	142	130
60.0	7.4	30.4	10	1.7	72	81	188	186	145	133
64.0	7.9	30.7	10	1.7	71	79	188	186	147	134
68.0	8.4	31.0	10	1.7	72	80	187	185	149	136
72.0	8.9	31.3	10	1.6	73	81	188	187	149	137
76.0	9.4	31.9	10	1.6	73	81	188	187	151	139
80.0	9.9	31.7	10	1.6	74	81	188	188	151	140
84.0	10.4	31.6	10	1.7	72	81	188	187	152	141
88.0	10.9	32.0	9	1.6	71	80	188	187	153	141
92.0	11.4	32.1	9	1.6	72	81	188	187	152	141
96.0	11.9	32.3	10	1.6	72	81	187	187	152	141
100.0	12.4	32.4	10	1.6	73	81	188	187	152	141
104.0	12.9	32.4	10	1.6	73	81	188	187	152	141
108.0	13.4	32.4	10	1.6	73	81	188	187	153	142

TABLE F-8. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
 Vehicle 156 at 70° F ambient and 45 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dyno h.p.	Temperature, deg. F				Trans.	Diff.
					Air to Veh.	Air to Carb.	Coolant	Oil		
0.2	-	-	-	-	69	70	72	70	71	72
1.0	0.6	15.3	-	-	72	85	102	70	72	83
2.0	1.3	18.7	16	-	72	74	141	89	77	91
3.0	2.1	20.6	17	6.2	72	75	173	106	86	98
4.0	2.8	21.8	16	6.1	72	76	178	123	95	104
5.0	3.6	22.8	15	6.0	72	76	183	139	103	119
6.0	4.3	23.5	15	6.0	72	77	187	150	110	114
7.0	5.1	24.1	15	6.0	72	77	188	160	116	117
8.0	5.8	24.6	15	6.0	72	78	189	169	123	121
9.0	6.6	25.0	15	6.0	72	78	189	175	129	124
12.0	8.9	26.0	15	6.0	73	79	190	187	139	133
15.0	11.0	26.7	15	6.0	72	79	191	195	150	139
18.0	13.3	27.2	15	6.0	73	80	191	200	158	145
21.0	15.5	27.6	15	5.9	73	80	191	201	163	148
24.0	17.8	27.9	14	5.9	73	80	191	202	167	152
27.0	20.0	28.1	14	5.9	73	81	191	203	170	155
30.0	22.2	28.4	15	5.9	73	81	192	204	172	157
33.0	24.5	28.5	15	6.0	73	81	191	203	174	158
36.0	26.7	28.7	15	6.0	73	81	192	204	175	160
39.0	28.9	28.8	15	6.0	74	81	191	203	176	161
42.0	31.2	28.9	15	5.9	74	81	191	204	177	162
45.0	33.4	29.0	15	5.9	74	81	191	204	177	162
48.0	35.6	29.1	15	5.9	74	81	191	203	178	162
51.0	37.9	29.2	15	5.9	74	81	191	203	178	163
54.0	40.1	29.3	15	5.9	74	81	192	203	178	163
57.0	42.3	29.3	15	6.0	74	81	191	203	179	164
60.0	44.5	29.4	15	6.0	74	81	191	202	179	164

TABLE F-9. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 156 at 70° F ambient and 60 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Lyno h.p.	Temperature, deg. F					Trans.	Diff.
					Air to Veh.	Air to Carb.	Coolant	Oil	Oil		
0.5	-	-	-	-	69	70	70	70	70	70	72
1.0	0.7	11.8	25	14.6	73	75	110	70	73	73	88
2.0	1.7	15.2	26	14.5	72	75	161	98	93	93	101
3.0	2.6	16.8	24	14.6	73	76	178	128	107	107	110
4.0	3.6	17.9	23	14.0	73	77	189	150	119	119	118
5.0	4.6	18.7	22	14.3	74	80	191	162	129	129	125
6.0	5.6	19.3	22	14.2	74	80	193	177	136	136	131
7.0	6.6	19.8	22	14.1	74	81	193	188	144	144	136
8.0	7.6	20.3	22	14.0	74	82	194	197	151	151	140
9.0	8.6	20.6	22	14.0	74	83	195	204	157	157	144
12.0	11.6	21.4	22	14.0	72	81	195	213	172	172	155
15.0	14.5	22.0	22	14.1	74	83	196	217	183	183	163
18.0	17.5	22.4	22	14.1	75	83	197	220	190	190	169
21.0	20.4	22.7	22	14.0	73	82	197	221	195	195	174
24.0	23.4	23.0	22	14.0	75	83	197	222	198	198	177
27.0	26.4	23.2	22	14.1	74	83	197	222	200	200	180
30.0	29.3	23.4	22	14.0	74	83	196	221	201	201	183
33.0	32.3	23.5	23	14.1	75	84	197	222	202	202	184
36.0	35.3	23.6	23	14.1	74	83	196	221	202	202	186
39.0	38.2	23.7	23	14.1	75	84	197	221	202	202	186
42.0	41.2	23.8	23	14.1	73	83	196	222	203	203	187
45.0	44.1	23.9	23	14.1	75	84	196	222	203	203	188

TABLE F-10. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
 Vehicle 156 at 100° F ambient with air conditioner on and 30 mph

Time min.	Dist. miles	Fuel g/gal	Torque ft.-lb.	Lync n.e.	Air to Air to		Temperature, deg. F			
					veh.	Carb.	Coolant	Oil	Trans.	Lift.
0.2	-	-	-	-	95	100	99	95	98	93
1.0	0.4	18.5	12	1.8	100	102	115	99	99	-
2.0	0.7	21.5	10	1.6	101	104	142	105	103	-
3.0	1.4	22.5	10	1.6	101	105	167	117	107	-
4.0	1.9	23.4	9	1.8	100	105	185	130	114	-
5.0	2.4	24.1	10	1.8	101	107	166	141	120	117
6.0	3.0	24.6	9	1.8	102	110	187	151	125	120
7.0	3.5	25.1	10	1.7	101	110	189	159	131	125
8.0	4.0	25.5	10	1.8	100	111	190	177	137	126
9.2	4.6	25.9	9	1.8	103	113	191	173	142	129
12.0	6.0	26.0	9	1.9	101	113	192	185	153	134
15.0	7.5	27.2	10	1.7	101	113	193	194	164	134
18.0	9.0	27.9	9	1.7	101	114	184	189	173	144
21.0	10.5	27.9	9	1.7	102	115	185	207	177	148
24.0	12.0	28.2	9	1.7	101	114	195	204	184	151
27.3	13.7	28.5	9	1.7	101	114	185	205	187	153
30.0	15.0	28.7	9	1.7	103	116	195	206	190	155
33.0	16.5	28.8	9	1.7	101	114	195	205	191	157
36.0	18.1	29.0	9	1.7	101	115	196	208	193	158
39.0	19.0	29.1	9	1.7	102	115	195	206	193	159
42.0	21.1	29.2	9	1.6	101	115	195	205	194	160
45.0	22.6	29.4	9	1.7	102	115	195	206	194	161
48.0	24.1	29.5	9	1.7	101	114	195	206	195	162
51.0	25.6	29.6	9	1.7	101	114	195	206	195	162
54.0	27.1	29.6	9	1.7	101	114	195	206	195	163
57.0	28.6	29.7	9	1.7	101	114	195	206	195	163
60.0	30.1	29.8	9	1.7	101	114	195	206	195	164



TABLE F-11. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 156 at 100° F ambient with air conditioner on and 45 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Sync k.F.	AIR to		Temperature, deg. F		Trans.	Diff.
					veh.	Carb.	Coolant	Cil		
0.3	-	-	-	-	98	100	103	100	101	103
1.0	0.6	15.5	12	5.8	103	104	128	106	103	111
2.0	1.3	16.8	15	5.7	101	104	167	122	105	117
3.0	2.1	20.3	14	5.9	101	105	175	138	117	122
4.0	2.8	21.4	15	5.9	102	108	189	154	127	127
5.0	3.6	22.1	15	6.0	102	110	192	164	137	131
6.0	4.3	22.7	14	5.9	102	110	194	175	142	135
7.0	5.1	23.2	14	5.9	102	111	195	184	148	139
8.0	5.8	23.6	14	5.9	102	112	196	191	155	143
9.0	6.6	23.9	14	6.0	102	112	197	196	162	146
12.0	8.6	24.7	14	5.9	103	113	198	208	176	159
15.0	11.0	25.2	15	5.9	103	114	199	214	187	159
16.0	13.3	25.6	14	6.0	103	115	195	218	193	166
21.0	15.5	25.8	15	6.0	103	115	200	219	197	-
24.1	17.9	26.1	15	6.0	103	115	200	220	200	-
27.0	20.0	26.2	15	6.0	103	115	200	220	202	-
30.0	22.2	26.4	15	6.0	103	115	200	221	203	-
33.0	24.5	26.5	15	6.0	104	116	200	221	203	-
36.0	26.7	26.7	15	5.9	104	116	200	220	204	-
39.0	28.9	26.7	15	6.0	104	116	200	221	205	-
42.0	31.1	26.8	15	6.0	104	116	200	221	205	-
45.0	33.4	26.9	15	6.0	103	114	200	221	205	-
48.0	35.6	27.0	15	6.1	104	116	200	221	205	-
51.0	37.5	27.0	15	6.1	102	115	200	221	205	-
54.1	40.2	27.1	15	6.0	103	115	200	221	205	-
57.0	42.3	27.1	15	6.0	104	116	200	221	205	-
60.0	44.5	27.1	15	6.0	103	115	200	220	205	-



TABLE F-12. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
 Vehicle 156 at 100° F ambient with air conditioner on and 60 mph

Time min.	Dist. miles	fuel mpg	torque ft.lb.	dyno h.p.	Temperature, deg. F				Trans.	Diff.
					Air to veh.	Air to carb.	Oil	Coolant		
0.0	-	-	-	-	99	99	99	98	98	99
1.0	0.7	12.2	43	13.7	99	101	132	104	107	110
2.0	1.6	14.9	24	14.4	101	104	185	131	122	120
3.1	2.7	16.1	22	14.1	102	107	192	159	135	129
4.0	3.6	16.7	22	14.2	102	109	195	174	140	135
5.0	4.6	17.2	22	14.0	102	110	197	186	157	142
6.0	5.6	17.7	22	14.0	103	112	198	199	166	147
7.0	6.5	18.0	22	13.8	103	112	199	206	174	153
8.0	7.5	18.3	22	13.7	103	113	200	215	181	157
9.0	8.5	18.6	22	13.9	104	114	201	219	188	162
12.0	11.4	19.1	22	14.0	103	113	203	231	201	173
15.0	14.4	19.5	22	14.0	104	115	206	236	210	183
18.0	17.3	19.8	22	14.1	103	114	207	240	215	190
21.0	20.3	20.0	22	14.1	104	114	208	241	220	197
24.0	23.2	20.2	22	14.0	104	114	209	243	222	201
27.0	26.2	20.3	23	14.1	102	114	209	243	223	205
30.0	29.1	20.4	23	14.1	104	115	209	243	224	208
33.0	32.0	20.5	23	14.2	104	115	210	244	225	211
36.0	35.0	20.6	22	14.2	103	115	209	243	225	213
39.0	37.9	20.7	22	14.2	104	115	209	243	226	215
42.0	40.9	20.7	22	14.1	104	115	210	243	226	216
45.0	43.8	20.6	23	14.1	103	114	209	243	226	217

TABLE F-13. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 158 at 20° F ambient and 30 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.-lb.	Lync k.P.	Temperature, deg. F				Trans.	Diff.
					Air to Veh.	Air to Cark.	Coolant	Oil		
0.2	-	-	-	-	15	22	22	16	15	17
1.0	0.4	5.4	-	-	14	44	45	16	16	27
2.0	0.9	6.6	-	-	14	62	81	20	22	42
3.0	1.5	7.5	-	-	15	75	105	33	29	48
4.0	2.0	9.0	25	2.5	15	85	130	49	33	56
5.0	2.5	10.0	27	2.5	16	93	145	63	38	60
6.0	3.0	10.7	27	2.6	16	95	157	74	45	61
7.0	3.6	11.4	27	2.7	17	104	169	82	50	65
8.0	4.1	12.0	27	2.5	17	107	176	95	56	69
9.0	4.6	12.5	26	2.7	18	105	183	105	61	70
12.0	6.2	13.7	25	2.7	19	107	196	138	75	78
15.0	7.6	14.7	25	2.8	20	105	198	155	87	84
18.0	9.4	15.4	25	2.6	21	104	197	167	95	88
21.0	11.0	16.0	24	2.7	22	101	199	175	102	91
24.0	12.6	16.4	24	2.7	23	99	199	180	109	94
27.0	14.2	16.8	24	2.7	24	96	199	183	114	97
30.0	15.7	17.1	23	2.7	24	93	200	184	118	98
33.0	17.3	17.4	23	2.7	25	92	200	184	122	100
36.0	18.9	17.6	23	2.7	25	91	200	186	125	101
39.0	20.5	17.6	23	2.6	26	90	200	187	128	102
42.0	22.1	18.0	23	2.7	25	90	200	187	131	104
45.0	23.6	18.2	23	2.7	26	89	199	186	133	104
48.0	25.2	18.3	23	2.7	27	88	200	187	135	105
51.0	26.8	18.5	23	2.7	27	88	200	187	136	106
54.0	28.4	18.6	22	2.6	27	88	200	187	138	106
57.0	30.0	18.8	23	2.6	27	88	200	187	135	107
60.0	31.5	18.8	-	-	26	88	200	187	135	107

TABLE F-14. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 158 at 20° F ambient and 45 mph

Time min.	Dist. miles	fuel lbs	torque ft.lb.	MPG e.p.	Temperature, deg. F		Oil lbrs.	Lit.
					Air to veh.	Air to Carb.		
0.3	-	-	-	-	24	26	18	18
1.0	0.6	5.7	44	7.4	52	61	18	18
2.0	1.3	7.4	39	7.5	73	98	28	25
3.0	2.1	9.0	36	7.4	88	129	48	31
4.0	2.8	10.3	36	7.4	101	155	65	35
5.0	3.6	11.3	35	7.5	109	175	83	40
6.0	4.3	12.1	35	7.5	109	193	96	55
7.0	5.1	12.8	34	7.6	107	193	105	61
8.0	5.8	13.4	34	7.5	103	195	129	67
9.0	6.5	13.9	34	7.6	100	195	142	74
12.0	8.8	15.0	33	7.4	94	197	168	93
15.0	11.0	15.8	33	7.1	25	197	181	107
16.0	13.2	16.4	31	7.2	26	199	188	117
21.0	15.4	16.9	32	7.2	27	195	193	126
24.0	17.7	17.3	32	7.3	28	199	196	133
27.0	19.9	17.7	31	7.3	29	199	198	138
30.0	22.1	18.0	32	7.4	30	200	199	143
33.0	24.3	18.2	31	7.5	31	200	200	147
36.0	26.6	18.5	31	7.4	32	200	202	150
39.0	28.8	18.7	31	7.4	32	200	202	153
42.3	31.2	18.9	31	7.5	33	201	202	155
45.0	33.3	19.0	32	7.5	33	200	203	157
48.0	35.5	19.1	32	7.6	34	201	203	159
51.0	37.8	19.3	32	7.4	34	201	204	160
54.0	40.0	19.4	30	7.3	34	200	204	162
57.6	42.2	19.5	31	7.4	35	201	204	162
60.0	44.5	19.6	30	7.5	36	201	204	163

TABLE F-15. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
 Vehicle 158 at 20° F ambient and 60 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Hyno h.p.	Air to		Temperature, deg. F		Trans.	Diff.
					veh.	Carc.	Coolant	Oil		
0.5	-	-	-	-	12	22	24	16	16	16
1.0	0.6	5.2	62	19.0	15	55	64	17	16	42
2.0	1.6	7.6	52	18.0	16	83	116	33	25	59
3.0	2.0	8.3	50	18.1	17	103	155	60	36	67
4.0	3.6	10.4	50	18.2	19	107	183	85	45	77
5.1	4.7	11.3	49	18.2	20	101	192	108	56	84
6.0	5.6	11.8	48	18.2	21	96	195	129	65	89
7.0	6.0	12.3	48	18.2	23	92	197	149	74	94
8.0	7.6	12.6	47	18.2	24	90	197	164	82	99
9.3	8.9	13.2	46	17.9	25	84	197	178	95	104
12.0	11.6	13.8	46	17.9	27	70	199	196	114	112
15.0	14.6	14.3	46	18.0	30	59	199	207	132	118
18.0	17.6	14.8	45	18.0	32	55	200	213	146	124
21.0	20.5	15.1	44	18.1	34	52	201	217	157	129
24.0	23.5	15.3	44	18.0	35	52	202	219	166	133
27.0	26.5	15.5	45	17.9	37	52	202	221	173	136
30.0	29.5	15.7	45	18.1	37	53	202	222	178	139
33.0	32.5	15.9	44	18.1	38	53	203	222	183	142
36.0	35.5	16.0	44	18.1	39	54	203	223	186	144

TABLE F-16. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start Vehicle 158 at 45° F ambient and 30 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.-lb.	lyno r.p.m.	Temperature, deg. F				Lift.
					Air to veh.	Air to Carr.	Coolant	Oil	
0.2	-	-	-	-	43	44	44	43	45
1.0	0.4	6.9	-	-	45	69	72	45	46
2.1	1.0	9.0	27	2.5	47	87	102	52	49
3.0	1.5	10.7	25	2.5	47	99	124	63	51
4.0	2.0	12.9	26	2.6	47	110	142	74	55
5.0	2.5	13.1	25	2.6	47	115	157	87	60
6.0	3.0	13.5	24	2.6	47	104	170	96	71
7.0	3.5	14.0	24	2.6	47	99	180	105	65
8.0	4.1	15.2	24	2.6	47	97	189	119	70
9.0	4.6	15.7	24	2.6	45	96	195	128	76
10.0	5.1	16.9	23	2.4	47	37	197	149	73
11.0	5.7	17.3	22	2.5	47	31	197	164	92
12.0	6.2	17.9	22	2.5	47	74	193	174	101
13.0	6.6	18.4	21	2.5	48	74	197	174	111
14.0	7.1	18.8	22	2.5	46	74	199	180	116
15.0	7.6	19.1	21	2.5	47	73	199	184	122
16.0	8.1	19.4	22	2.5	47	74	199	187	137
17.0	8.6	19.7	22	2.6	46	72	199	187	134
18.0	9.1	19.9	22	2.6	47	72	199	188	134
19.0	9.6	20.1	21	2.6	47	74	200	190	137
20.0	10.1	20.3	22	2.6	48	73	199	190	139
21.0	10.6	20.5	22	2.6	46	72	200	189	141
22.0	11.1	20.7	21	2.6	47	73	200	190	143
23.0	11.6	20.8	22	2.6	48	73	200	190	145
24.0	12.1	20.9	22	2.6	47	73	200	190	145
25.0	12.6	21.0	21	2.6	47	73	200	190	147
26.0	13.1	21.1	22	2.6	47	74	200	190	147
27.0	13.6	21.2	21	2.6	47	73	200	190	148
28.0	14.1	21.3	21	2.6	47	73	200	190	148
29.0	14.6	21.4	21	2.6	47	73	200	190	149
30.0	15.1	21.5	21	2.6	47	73	200	190	149

TABLE F-17. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
 Vehicle 158 at 45° F ambient and 45 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dyno h.p.	Temperature, deg. F				Diff.	
					Air to veh.	Air to Carb.	Coolant	Oil		Trans.
0.3	-	-	-	-	47	52	51	45	45	43
1.0	0.6	6.8	-	-	47	78	81	46	47	58
2.0	1.4	9.5	36	7.9	46	101	119	60	53	66
3.0	2.1	11.3	35	8.0	46	113	146	76	55	73
4.0	2.9	12.5	35	8.0	47	98	170	90	67	79
5.0	3.6	13.5	34	7.9	47	92	186	103	74	84
6.0	4.4	14.3	38	8.1	48	85	192	116	81	88
7.0	5.1	14.8	33	7.8	46	81	194	132	86	92
8.0	5.9	15.2	33	7.7	47	72	196	152	92	95
9.0	6.6	15.6	32	7.6	47	66	197	160	98	98
12.0	8.7	16.5	33	7.6	48	64	198	179	114	106
15.0	11.2	17.2	32	7.8	47	63	199	191	128	112
18.0	13.4	17.7	32	7.8	47	62	200	198	138	116
21.4	15.9	18.2	32	7.9	47	62	200	201	146	120
24.0	18.0	18.5	31	7.9	47	62	200	204	152	122
27.0	20.2	18.8	31	7.8	47	62	200	205	157	125
30.0	22.5	19.0	31	7.8	47	62	200	206	161	127
33.0	24.7	19.2	30	7.8	47	62	201	206	164	129
36.0	27.0	19.4	31	7.8	48	62	201	207	167	129
39.0	29.3	19.6	30	7.7	48	62	201	207	169	130
42.0	31.5	19.7	31	7.9	48	62	201	207	171	131
45.0	33.8	19.8	31	7.9	48	63	201	207	172	132
48.0	36.1	19.9	31	7.7	49	62	201	207	174	133
51.0	38.3	20.0	32	7.9	48	62	201	207	174	133
54.0	40.6	20.1	31	7.9	48	63	201	208	176	133
57.0	42.9	20.2	31	7.8	48	63	201	208	176	134
60.1	45.1	20.3	32	7.8	48	64	202	208	177	134

TABLE F-18. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
 Vehicle 158 at 45° F ambient and 60 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dyno h.p.	Temperature, deg. F				Trans.	Diff.
					Air to Veh.	Air to Carb.	Coolant	Oil		
0.3	-	-	-	-	43	50	49	45	45	43
1.0	0.7	6.1	54	18.4	45	80	86	45	47	61
2.0	1.6	9.1	49	18.4	47	110	135	67	54	73
3.0	2.6	10.7	48	18.6	48	94	171	88	63	83
4.0	3.6	11.8	47	18.6	47	89	197	107	73	90
5.0	4.6	12.5	47	18.6	47	76	196	132	81	96
6.0	5.6	13.0	46	18.0	47	62	197	150	91	101
7.0	6.6	13.3	46	18.0	48	61	198	165	101	106
8.0	7.6	13.6	45	18.0	49	61	199	178	110	110
9.0	8.6	13.8	45	18.0	49	60	200	187	120	114
12.0	11.6	14.4	45	18.1	50	62	202	204	141	122
15.0	14.6	14.9	44	18.2	49	61	203	215	158	130
18.0	17.5	15.2	44	18.3	50	62	203	220	170	137
21.0	20.5	15.4	44	18.3	50	62	204	223	179	142
24.0	23.5	15.6	44	18.4	50	63	204	225	185	146
27.0	26.5	15.6	45	18.3	51	63	204	226	190	149
30.0	29.5	15.9	44	18.3	51	63	204	226	194	153
33.0	32.5	16.0	44	18.3	51	63	204	226	198	155
36.0	35.4	16.1	44	18.3	52	64	204	226	200	157
39.0	38.4	16.2	44	18.3	52	64	205	227	202	159
42.0	41.4	16.3	44	18.5	52	65	205	227	204	160
45.0	44.4	16.4	45	18.6	52	65	205	227	205	166



TABLE F-19. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 158 at 70° F ambient and 30 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Hyno h.p.	Air to		Temperature, deg. F			Liff.
					veh.	Carb.	Coolant	Oil	Trans.	
0.4	-	-	-	-	74	77	74	70	70	70
1.0	0.4	10.2	24	2.5	70	95	97	71	72	74
4.0	0.9	13.2	23	2.3	70	114	123	77	74	79
5.0	1.4	14.7	22	2.3	72	97	145	86	77	82
4.0	1.9	15.6	22	2.2	72	90	166	97	82	85
5.0	2.4	16.3	22	2.4	72	84	184	108	86	88
6.0	2.9	16.9	23	2.2	72	82	197	119	90	91
7.0	3.4	17.3	22	2.3	72	82	195	129	94	94
6.0	3.9	17.8	22	2.4	73	83	197	139	98	96
9.0	4.4	18.2	22	2.3	72	83	197	147	101	98
12.0	5.9	19.1	22	2.4	72	83	199	167	113	104
15.0	7.5	19.8	21	2.4	72	83	200	179	122	108
16.0	9.0	20.3	21	2.4	72	83	201	187	129	112
21.1	10.6	20.8	21	2.4	73	84	201	190	136	116
24.0	12.1	21.1	21	2.4	72	84	201	193	142	118
27.0	13.6	21.4	21	2.5	72	84	202	194	147	121
30.0	15.2	21.7	20	2.4	72	84	202	196	151	123
35.0	16.7	21.9	21	2.4	74	84	202	197	154	125
36.0	18.2	22.1	21	2.4	72	84	201	197	157	126
39.0	19.8	22.3	20	2.4	72	84	202	197	159	128
42.0	21.3	22.4	21	2.4	72	84	202	197	161	129
45.0	22.8	22.5	20	2.4	72	83	202	198	162	129
45.0	24.4	22.7	20	2.4	73	85	202	198	164	130
51.0	25.9	22.8	20	2.4	72	85	202	198	165	131
54.0	27.4	22.9	21	2.4	72	84	202	198	166	131
57.0	29.0	23.0	20	2.4	72	84	201	198	167	132
60.0	30.5	23.0	20	2.4	72	84	201	198	167	132

TABLE F-20. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start Vehicle 158 at 70° F ambient and 45 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dync h.p.	Temperature, deg. F				Trans.	Diff.
					Air to Veh.	Air to Carb.	Cocclant	Oil		
0.3	-	-	-	-	72	77	74	70	70	70
1.0	0.6	9.3	33	7.5	71	106	105	72	71	78
2.0	1.3	12.4	32	7.6	70	96	140	84	76	85
3.0	2.1	13.8	33	7.6	70	81	169	96	81	90
4.0	2.8	14.8	31	7.6	71	77	196	107	88	96
5.0	3.5	15.5	31	7.6	72	78	196	124	93	100
6.0	4.3	16.1	31	7.6	72	80	199	143	99	103
7.0	5.0	16.5	31	7.6	73	81	199	156	107	107
8.0	5.8	17.0	31	7.6	73	81	200	166	114	110
9.0	6.5	17.3	30	7.6	73	81	200	174	119	113
12.0	8.7	18.2	30	7.7	74	82	203	192	136	120
15.0	11.0	18.8	30	7.7	74	83	203	202	148	126
18.0	13.2	19.3	30	7.7	74	83	204	207	159	131
21.0	15.4	19.6	30	7.7	75	83	204	211	167	135
24.0	17.7	19.9	30	7.7	73	82	205	213	174	139
27.0	19.9	20.2	30	7.6	73	83	205	213	178	141
30.0	22.1	20.4	30	7.6	74	83	205	214	183	144
33.0	24.4	20.5	29	7.8	74	83	205	215	186	145
36.0	26.6	20.7	29	7.7	74	82	205	214	188	148
39.0	28.8	20.8	30	7.7	75	83	205	215	190	149
42.0	31.1	20.9	30	7.7	73	83	205	215	191	150
45.0	33.3	21.0	29	7.7	74	83	204	214	193	151
48.0	35.5	21.1	30	7.8	75	83	205	215	194	152
51.0	37.7	21.1	30	7.8	73	83	205	215	194	153
54.0	40.0	21.2	30	7.8	74	83	204	215	195	154
57.0	42.2	21.3	30	7.8	75	84	204	214	195	154
60.0	44.4	21.3	30	7.8	73	83	204	214	195	154

TABLE F-21. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
Vehicle 158 at 70° F ambient and 60 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dyno h.p.	Temperature, deg. F					Trans.	Diff.
					Air to Veh.	Air to Carb.	Coolant	Oil			
0.2	-	-	-	-	70	73	72	69	69	69	69
1.0	0.6	8.6	65	18.2	72	107	107	70	66	66	79
2.0	1.6	10.2	46	18.5	73	79	157	88	77	77	91
3.0	2.6	11.9	45	18.5	73	79	198	106	85	85	99
4.1	3.7	12.7	45	18.5	74	81	199	135	95	95	106
5.0	4.6	13.2	45	18.6	74	83	201	152	105	105	111
6.0	5.6	13.6	44	18.5	74	84	203	170	116	116	116
7.0	6.6	14.0	44	18.6	73	83	204	184	126	126	120
8.0	7.6	14.3	44	18.4	74	83	204	194	135	135	124
9.0	8.6	14.6	43	18.7	74	84	205	202	144	144	128
12.0	11.6	15.1	43	18.1	74	83	206	218	163	163	138
15.0	14.5	15.5	42	18.1	74	85	207	223	177	177	147
16.0	17.5	15.8	43	18.2	75	85	206	227	187	187	154
21.0	20.5	16.0	42	18.1	74	85	206	230	195	195	159
24.0	23.4	16.2	43	18.2	74	84	207	231	202	202	164
27.0	26.4	16.3	43	18.0	75	85	207	231	206	206	167
30.0	29.4	16.5	43	18.2	75	85	207	232	209	209	170
33.0	32.3	16.5	43	18.1	74	85	207	232	212	212	173
36.0	35.3	16.6	43	18.2	75	85	207	232	214	214	175
39.0	38.3	16.7	42	18.1	76	85	207	232	215	215	177
42.0	41.2	16.8	43	18.1	76	85	207	232	216	216	179
45.0	44.2	16.8	42	18.2	75	84	207	233	217	217	180

TABLE F-22. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
 Vehicle 158 at 100° F ambient with air conditioner on and 30 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dyno h.p.	Temperature, deg. F					Trans.	Diff.
					Air to Veh.	Air to Carb.	Coolant	Oil			
0.3	-	-	-	-	98	101	-	100	100	101	101
1.0	0.4	11.7	20	2.4	99	109	-	101	101	101	103
2.0	0.9	13.6	21	2.4	101	107	-	107	104	106	106
3.0	1.4	14.3	20	2.4	101	107	-	117	107	108	108
4.0	1.9	14.9	20	2.4	100	108	-	128	110	110	110
5.0	2.4	15.2	20	2.4	101	112	-	140	115	112	112
6.0	3.0	15.5	20	2.4	101	114	-	150	119	114	114
7.0	3.5	15.8	20	2.4	101	115	-	157	124	116	116
8.0	4.0	16.0	19	2.4	102	116	-	165	129	118	118
9.0	4.5	16.2	19	2.4	102	118	-	172	134	119	119
12.0	6.0	16.8	19	2.4	101	119	-	188	146	125	125
15.0	7.5	17.2	19	2.4	101	120	-	197	158	129	129
18.0	9.0	17.5	19	2.4	101	120	-	203	166	133	133
21.0	10.5	17.7	19	2.4	102	123	-	206	174	136	136
24.0	12.0	17.9	20	2.4	102	122	-	207	179	140	140
27.0	13.6	18.1	19	2.4	102	122	-	208	182	142	142
30.0	15.1	18.2	19	2.4	102	122	-	209	186	144	144
33.0	16.6	18.3	20	2.4	102	124	-	211	189	146	146
36.0	18.1	18.4	19	2.4	102	123	-	210	190	148	148
39.0	19.6	18.5	18	2.4	101	122	-	210	191	149	149
42.0	21.1	18.6	19	2.4	102	121	-	209	193	151	151
45.0	22.7	18.7	19	2.4	103	122	-	211	194	152	152
48.0	24.2	18.8	19	2.4	101	122	-	210	195	153	153
51.0	25.7	18.9	19	2.3	103	120	-	210	194	153	153
54.0	27.2	18.9	18	2.3	103	122	-	210	196	154	154
57.0	28.7	19.0	18	2.3	101	121	-	209	196	154	154
60.0	30.2	19.1	19	2.3	102	120	-	208	196	155	155

TABLE F-23. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
 Vehicle 158 at 100° F ambient with air conditioner on and 45 mph

Time min.	Dist. miles	Fuel mpg	Torque ft.lb.	Dyno h.p.	Temperature, deg. F				Trans.	Diff.
					Air to veh.	Air to Carb.	Coolant	Oil		
0.3	-	-	-	-	103	101	-	99	99	99
1.0	0.6	10.2	31	7.9	100	105	-	102	104	98
2.0	1.3	12.1	31	7.9	101	107	-	113	107	109
3.0	2.1	13.0	30	8.1	102	109	-	130	112	113
4.0	2.8	13.6	30	8.0	102	113	-	140	118	117
5.0	3.6	14.1	29	8.0	102	115	-	156	126	120
6.0	4.3	14.5	30	8.0	102	117	-	170	135	123
7.0	5.1	14.8	29	8.1	102	118	-	181	142	126
8.0	5.9	15.1	29	8.1	103	119	-	189	149	129
9.0	6.6	15.3	29	8.1	103	120	-	197	155	132
12.0	8.9	15.9	29	8.1	102	120	-	211	170	140
15.0	11.1	16.3	28	7.9	103	121	-	219	182	146
18.0	13.4	16.6	29	7.9	103	121	-	223	190	152
21.0	15.7	16.8	29	8.0	103	121	-	226	196	156
24.0	17.9	17.0	29	8.1	104	121	-	227	201	160
27.0	20.2	17.1	30	8.0	103	121	-	229	205	163
30.0	22.5	17.3	29	8.0	103	121	-	229	208	166
33.0	24.7	17.4	29	8.0	103	121	-	230	210	168
36.0	27.0	17.5	29	8.0	102	121	-	230	211	170
39.0	29.3	17.5	29	8.0	104	121	-	230	212	171
42.0	31.5	17.6	29	8.1	103	121	-	231	213	172
45.0	33.8	17.7	29	8.1	102	121	-	230	214	174
48.2	36.2	17.7	29	8.1	103	121	-	230	214	174
51.0	38.4	17.8	29	8.1	104	122	-	230	214	174
54.0	40.6	17.8	29	8.1	103	121	-	231	215	175
57.0	42.9	17.9	28	8.1	103	121	-	230	215	176
60.0	45.2	17.9	28	8.1	103	121	-	230	215	176

TABLE F-24. - Time, distance, fuel economy, drive shaft torque, and vehicle temperatures during steady-state operation from a cold start  
 Vehicle 158 at 100° F ambient with air conditioner on and 60 mph

Time min.	Dist. miles	fuel mpg	torque ft.lb.	Dyno h.p.	Temperature, deg. F				Trans.	Diff.
					Air to veh.	Air to Carb.	Coolant	Oil		
0.3	-	-	-	-	101	101	-	100	100	100
1.0	0.6	8.1	37	18.3	97	101	-	102	101	105
2.0	1.6	10.2	44	18.8	100	107	-	120	110	113
3.0	2.6	11.1	43	18.8	101	110	-	140	117	118
4.0	3.6	11.6	43	19.0	102	116	-	162	129	124
5.0	4.6	11.9	44	18.8	102	118	-	182	143	130
6.0	5.7	12.2	43	18.8	103	121	-	199	155	136
7.0	6.7	12.3	43	19.0	103	122	-	211	165	140
8.0	7.7	12.4	43	19.1	104	122	-	222	173	144
9.0	8.7	12.5	42	19.0	104	122	-	230	180	149
12.0	11.6	12.7	43	19.0	105	126	-	242	196	161
15.0	14.6	12.6	43	18.8	105	126	-	247	207	170
18.0	17.6	12.9	43	19.0	105	126	-	250	216	178
21.0	20.5	12.9	42	18.9	104	125	-	253	222	186
24.0	23.5	13.0	43	18.7	105	127	-	254	226	191
27.0	26.5	13.0	43	19.2	106	127	-	255	230	196
30.0	29.5	13.1	44	18.9	104	125	-	254	231	200
33.0	32.5	13.1	44	18.9	104	126	-	255	234	204
36.0	35.5	13.1	44	19.0	105	126	-	255	235	207
39.0	38.5	13.2	44	19.0	103	126	-	256	236	210
42.0	41.5	13.2	43	18.8	106	127	-	256	237	211
45.0	44.5	13.2	43	18.7	104	126	-	256	237	213



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